Popular Astronomy.

Vol. XXII, No. 2. FEBRUARY, 1914. Whole No. 212

THE STUDY OF THE STARS.*

EDWARD C. PICKERING.

The object of the American Association is the advancement of science. This is a very different matter from the diffusion of human knowledge. The universities and colleges provide liberally for the latter subject, but neglect the former almost entirely. Science is advanced by many individuals who hold offices in the universities, but seldom as a part of their official duties. Few professors are allowed to regard research as a portion of their college work, and still less frequently are appropriations made or funds provided for original investigation. Astronomy is almost the only exception to this rule, and even here in general, the time of the officers is mainly devoted to teaching. Observatories devoted to research like McCormick, Lick and Harvard are supported by funds given specifically for their use, and receive little, or no aid, from the general funds of the universities with which they are associated. It is probable that American universities devote one hundred times as much money to the diffusion of human knowledge, as to its advancement. The great progress made in America in some departments of astronomy is due to the fact that certain wealthy men and women have been willing to give large sums of money for this object. No other country is so fortunate in this respect, although in recent years in Germany large appropriations are being made by the government for similar purposes.

The income of certain funds like the Elizabeth Thompson, Bache and Watson funds is also available, but while these are of the greatest value in aiding particular individuals, the amount is too small to materially advance the entire science. The large funds which might aid individual research are unfortunately employed for other purposes. Scarcely any appropriations have been made to women from these funds. One of the greatest needs of science in America is a fund of moderate size, capable of aiding the men of real genius. The number of such men is not large, and a judicious distribution of a few thousand dollars annually would probably yield greater results than could be obtained in any other way.

* Address of the President of the American Association for the Advancement Science, Atlanta, December 29, 1913. Reprinted from *Science*, January 2, 1914.

A visit to Europe last summer in order to attend the meetings of two national and two international astronomical societies enabled me to visit several of the larger observatories and to interchange views with the leading astronomers of the world. I have accordingly selected as my subject for this evening "The Study of the Stars," and I shall endeavor to transmit to you the latest views as well as the history of this department of human knowledge. It is my wish to present to my professional friends certain facts of a technical nature, and at the same time to make these clear to those of my hearers who have no previous knowledge of the subject. Astronomy has been called not only the oldest of the sciences but that which has conferred the greatest benefits on man by rendering international commerce possible. While this may be true of the past, the value of the astronomy of the present day lies in its extension of human knowledge and enabling the mind of man to traverse fields which until recently appeared to be hopelessly beyond his ken.

The first catalogue of the stars was made by Hipparchus about B.C. 128, and was inserted by Ptolemy in the "Almagest," for fourteen centuries the authority in astronomy for the world. This catalogue, which contained more than a thousand stars, gave both their positions and brightness. The earliest copy that is known of the "Almagest" is in the Bibliothèque National in Paris. It is a beautiful manuscript in uncial characters of the ninth century. The other later manuscripts unfortunately differ from it and from each other, so that there is some uncertainty regarding two thirds of the stars, owing to errors of copying. A careful study of these discrepancies has been made by Dr. Peters, of Clinton, and Mr. Knobel, of London. Each spent several years on this work, and all the papers are in the hands of Mr. Knobel. He is now preparing the entire work for publication and it is hoped that it will be in the hands of the printer in a few months.

A manuscript of nearly the same age is in the library of the Vatican, and this year a revised edition of it has been published. If we had a correct copy of the original work, it would have a great value at the present time. Half a century ago it would probably have given the best existing values of the proper motions of the stars which it contained, but recent observations enable us to compute their positions in the time of Hipparchus, more accurately than he could observe them, assuming that the motion was rectilinear. This work might, however, throw light on a possible curvature of the motions. The observations by Hipparchus of the light of the stars have a value that will be considered later.

The first accurate measures of the positions of the stars were made in the middle of the eighteenth century. The catalogue of Bradley in 1755 is even at the present time one of the best means of determining

the early positions of the stars. A large number of similar, but later, observations by Hornsby are still unpublished. During the next hundred years the meridian circle, which is at present the standard instrument for determining the places of the stars, was gradually evolved. In this instrument, a telescope is mounted so that it will point only to stars in the meridian, that is, to stars exactly north or south of the observer The declination of stars corresponding to the latitude of points on the surface of the earth, are then measured by a finely graduated circle. Owing to the motion of the earth all stars cross the meridian twice during every twenty-four hours. The right ascension, corresponding to longitude, will be given by the time of transit. At first this time was founded by the "eye and ear" method in which the observer counted the ticks of an accurate timepiece and compared them mentally with the instant at which the star appeared to cross a wire in the field of view of the telescope. About the middle of the nineteenth century a great advance was made by recording the time electrically on a chronograph. This method was known for many years as the "American" method, owing to its introduction and general adoption in this country. This continued to be the standard method almost to the present time, and an enormous number of observations have been accumulated in this way, the total cost amounting to millions of dollars. Perhaps the most valuable work of this kind is that of the *Astronomische Gesellschaft*, which, by international coöperation, secured accurate observations of the positions of one hundred and sixty-six thousand stars. All stars of the ninth magnitude, and brighter, north of declination $-23°$ are included. Of the twenty zones, seven were observed in Germany, four in the United States, three in Russia, one each in Algeria, Austria, England, Holland, Norway and Sweden. Of the American zones, one was observed at Albany, one at Washington and two at Cambridge. Each of the latter occupied the time of an observer and several assistants for twenty years. It was expected that these stars would be reobserved after an interval of about fifty years, to determine the proper motions, or annual changes in position. As the time is approaching when this great work should be undertaken, careful consideration should be given to it. Fortunately, the twentieth century has already developed two new methods which might replace the older plans. The first of these is the transit micrometer, in which a motion is given to the wire in the field of the telescope so that it shall follow closely the motion of the image of a star as it transits through the field. A wide difference of opinion exists among leading atronomers as to the best method of securing this motion. In the earlier instruments constructed by Repsold, the motion was given by a screw turned by the two hands alternately. This method certainly gives excellent results and is still used largely in

geodetic work. Any one who has tried it will find that with the rapid motion of an equatorial star under a high power it is difficult to satisfy himself that the wire always bisects the star. If clockwork is used, the rate must vary with the declination and it is strange that this is not done by electrical control, instead of the somewhat crude mechanical devices now employed. The wire records its position automatically on a chronograph at short intervals. The plan of permitting this record only when the observer is satisfied that coincidence takes place, as is done at Heidelberg, seems a good one. Evidently a certain relative motion will give better results than a greater or less motion. It would appear to follow logically that this apparent motion should be given to all stars and the record permitted only for the few seconds of apparent coincidence. We can expect no better results than those obtained with a filar micrometer. The best plan may therefore prove to be to give a motion to the wire nearly equal to that of the star, whatever the declination of the latter, by a suitable variation of the clockwork. The best rate could readily be determined by observing stars at different distances from the pole. Successive settings should then be made as with a filar micrometer, closing the circuit on the chronograph only when the bisection was satisfactory. A similar setting should also be made for the declinations. The two coördinates could thus be determined with an accuracy substantially the same as that of a filar micrometer. Experience has shown that one star a minute can be observed in both coördinates with the transit micrometer. There can be little doubt that positions could thus be obtained with much greater accuracy than by the methods now in use. The special advantage would be the elimination of systematic errors.

A second method of determining positions, recently developed at the Allegheny Observatory, is by plates taken with a photographic doublet. Ordinary plates must be replaced by those of plate glass. By taking suitable precautions positions may be determined of even the faintest stars, with an accuracy at least equal to that of a meridian circle. To obtain the best results, the field should be about five degrees square on an 8×10 plate. The focal length of the telescope would accordingly be about two metres. The large field would permit the constants of each plate to be derived from stars as bright as the eighth magnitude. The economy of this method would be very great, as compared with a meridian circle. The usefulness of the latter instrument appears to be confined to observations of the brighter stars. Accordinaly, its aperture may be reduced. The ideal plan would apparently be to divide the sky into regions five degrees square and select in each, five or more stars of about the eighth magnitude and of approximately the same class of spectrum as Class K, so that all should have about the same

color. The positions of these should be determined with the greatest possible accuracy with meridian circles, as described above. Some brighter stars should be included to render available the vast number of observations of these objects made in the past. Positions of the stars in the Gesellschaft catalogues and all fainter stars should be determined by photography.

Various attempts are now being made to determine the absolute positions of the stars by means of photography. It appears probable that a pier placed under ground will remain free from irregular motions, and that if this can be accomplished, the absolute positions of the stars near the equator can be found by photography. To determine the equinox Venus and Mercury should be photographed as well as the sun. By the very satisfactory coöperation of the Princeton, Yale and Harvard observatories the position of the moon is now determined by photography. The results of a preliminary discussion indicate an accuracy at least equal to that of the best meridian determinations, those of the Greenwich Observatory.

Excellent progress is also being made in determining the parallax of the stars by photography. The recent increase in accuracy is at least ten fold, or that of another place of decimals. A hundredth of a second of arc can now be determined with greater accuracy than a tenth of a second, twenty or thirty years ago.

The just criticism has been made of American astronomers that while they have contributed more than their share of the work in astrophysics the older science of astronomy of position has been greatly neglected. This is partly due to the fact that much of this work has been left to the United States Naval Observatory, which in the past has failed to justify the liberal appropriations made for its support. While Congress has given it for many years a much larger income than that of any other observatory in the world, the law has been such that it is impossible to attain the best results. The superintendent must be a naval officer, instead of an astronomer, and even then must go to sea after a short term. Accordingly, the Naval Observatory during a period of 37 years had 20 superintendents with an average term of less than two years. The Greenwich Observatory during a period of 235 years from 1675 to 1910 has had 8 astronomers royal with an average term of 29 years. The work of the latter institution with but half the income has greatly exceeded that of the Naval Observatory. It should be stated, however, that within the last few weeks, the Naval Observatory has established an admirable wireless time service by which any one can obtain, at trifling expense, accurate time within one tenth of a second. The Navy has no need of a great observatory, from which it derives but little credit. Three successive boards of visitors have pointed out the

present unfortunate conditions, but the necessary action has not been taken by Congress. The obvious remedy is to remove the observatory to another department, or place it under the direction of the Smithsonian Institution, and appoint an astronomer at its head. What grander field of work could be undertaken by this observatory than that desired by astronomers and neglected elsewhere. For instance, computers of double star orbits are continually complaining that while a surplus of measures of the easy objects are available, many difficult objects are neglected, although measures of them are greatly needed. The same is true of the asteroids, of variable stars, and in fact in almost every department of astronomy. By making the observations desired by experts, every hour would be saved, and work of the greatest value accumulated.

Astrophysics assumed prominence as a science about forty years ago, although it was foreshadowed by certain far-seeing astronomers like the Herschels, G. P. Bond, Huggins, Draper and others. One department, the study of the light of the stars, was developed much earlier, originating in the Almagest, and its revision a thousand years later by Sûfi. These catalogues show that the relative brightness of the stars has not changed sensibly during the last two thousand years. Also, that the human eye has the same sensitiveness to different colors, now as then. Stellar brightness was made a precise science by that great astronomer, William Herschel. His six catalogues, two of which remained unknown for eighty years, give precise measures of the light of the three thousand stars contained in them with an accuracy comparable with recent work.

In 1877, stellar photometry was taken up on a large scale at Harvard. Since then, more than two million photometric settings have been made. A station in Arequipa, Peru, permitted the southern stars to be observed on the same system as the northern stars. We have now, accordingly, measures of about eighty thousand stars, including all of the seventh magnitude and brighter, many of the ninth magnitude, and some as faint as the thirteenth magnitude. The excellent work of the Potsdam Observatory gives measures of the light of fourteen thousand stars including all northern stars of the magnitude 7.5, and brighter. The Potsdam and Harvard systems agree admirably if a correction is applied for the color or spectrum of the stars. They should never be combined, or compared, unless this correction is applied.

Stellar photography, originating in the work of George Bond in 1857, has revolutionized many departments of astronomy. The great work of a chart of the entire sky, undertaken by the Paris Observatory in coöperation with several others, is a sad example of the danger of undertaking a work on too large a scale. Although several observatories have been continually at work upon it for a quarter of a century, it has

been predicted that at least fifty years must elapse before it is completed, and no positions of any southern stars have yet been published. In striking contrast to this is the early completion of the Cape Photographic Durchmusterung which gives the positions and magnitudes of nearly half a million stars south of $-19°$. It illustrates the results of the happy combination of skilful planning with routine organization, conducted on a very large scale. The extension of this work to the North Pole is now being planned, but with the additional condition that the color index as well as the photographic magnitude will be determined. The former will be found by photographing the stars by means of their yellow or red, as well as with their blue, light, the difference in the magnitudes giving the color index. Much might be said of the numerous applications of photography to the determination of stellar magnitude. The sixty-inch reflector of the Mount Wilson Observatory, using exposures of several hours, has succeeded in photographing stars as faint as the twentieth magnitude. An international committee, with members from England, France, Germany, Russia, Holland and the United States, has adopted a scale of magnitudes based on two investigations made at Harvard. One of these was made with the meridian photometer, and the other is an elaborate investigation by Miss H. S. Leavitt of the photographic magnitude of seventy-six stars near the North Pole. A standard scale is thus provided from the first to the twentieth magnitude. We may say from the minus twenty-sixth to the twentieth magnitudes, since accordant results for the light of the sun have been obtained by Professors W. H. Pickering and E. S. King. For many purposes, photography may well replace visual photometric measures, since for stars brighter than the fifteenth magnitude photographs may be taken with yellow light. One of the principal uses of measures of the light of the stars in the study of the variables, or those in which the brightness is not constant. A bibliography of these by Miss Cannon is recorded on about forty thousand cards. The number of known variables is now about forty-five hundred, of which three quarters have been discovered by photography, at the Harvard Observatory. There are several kinds of variable stars. Variables of long period undergo changes which repeat themselves somewhat irregularly in a period of several months, and at maximum are often several thousand times as bright as at minimum. The most useful work that an amateur can do with a small telescope is the observation of these objects. An important work undertaken by the British Astronomical Association has been the observation of variable stars. During the last thirteen years they have accumulated twenty thousand such observations, all reduced to the same scale, which is that of the Harvard Photometry. Similar work in this country has accumulated ten and

sixteen thousand observations in the last two years, respectively. Variables of short period complete their changes in a few days, or hours. Professor Bailey has found five hundred such objects in the globular clusters. In one of these clusters, Messier 3, out of a thousand stars one seventh are variable, all have a period of about half a day, and their periods are known within a fraction of a second. Their light changes so rapidly that in one case it doubles in seven minutes. It is a strange thought that out of a thousand stars, looking exactly alike, there should be a hundred little chronometers keeping perfect time, and whose rate is known with such accuracy. About a hundred and fifty variables belong to the Algol class, in which the light is uniform for a large part of the time, undergoing a sudden diminution at regular intervals. This is due to the eclipse of two bodies, one darker than the other, revolving around their common center of gravity. An elaborate theoretical study of this problem has been made at the Princeton Observatory and, largely from the photometric and photographic magnitudes made at Harvard and elsewhere, the dimensions of a large number of these systems have been determined.

Photography still can scarcely compete with other methods where the greatest accuracy is desired, as for instance, the measures with the polarizing photometer by the late Oliver C. Wendell. The masterly use of the selenium photometer by Professor Stebbins gives results for bright stars of still greater accuracy, while the experiments in Germany with the photo-electric cell by Rosenberg and Guthnick give results which promise to revolutionize our present methods. The principal source of error appears to be the varying transparency of the air. The trial of the instrument in a location where the air is exceedingly clear and steady for long periods is greatly to be desired.

During the last twenty-five years photographs have been obtained by the Harvard Observatory in order to furnish a history of the stellar universe. Two similar 8-inch photographic doublets have been used, one mounted at Cambridge for the northern, and the other at Arequipa for the southern stars. With each of these instruments about forty thousand photographs have been taken. The total weight of these plates is about forty tons. As each plate covers a region ten degrees square, every part of the sky has been photographed, on the average a hundred times. This work is now supplemented by two small Cooke anastigmat lenses, each having a field thirty degrees square. The number of plates taken with these two instruments are nine thousand, and fourteen thousand, respectively. The exposures with the larger instruments are, in general, ten minutes, showing stars of the thirteenth magnitude. The exposures with the smaller instruments are one hour, showing stars of the eleventh magnitude. A continuous history

of the sky is thus furnished from which the magnitude and position of any stellar object of sufficient brightness can be determined for a large number of nights during the last quarter of a century. A striking illustration of the value of this collection occurred when the planet Eros was discovered in 1898. It appeared that this object was nearer the earth in 1894 than would occur again for thirty-five years. An examination of the photographs showed its presence on 23 plates, and from their positions the parallax of the sun and mass of the earth were determined with an accuracy equal to that of any of the methods previously used, and on which an enormous amount of time and money had been spent.

For many years the Kiel and Harvard observatories have served as distributing centres of astronomical discoveries and observations in Europe and America, respectively. The last new star which is known to have appeared, Nova Geminorum, No. 2, was discovered by Enebo at Dombaas, Norway, on Tuesday, March 13, 1912. The cable message was received at Cambridge Wednesday morning, and the star was observed at several American observatories the next evening, or the night following its discovery. An examination of the Harvard photographs showed that two plates had been taken on the preceding Sunday, March 11, on which no trace of the Nova was visible, and two on Monday, March 12, showing it of nearly its full brightness. Photographs taken Wednesday compared with those obtained a few days later showed the wonderful change in its spectrum, from the solar type with dark lines, to the typical spectrum of a Nova with bright lines.

There is no department of astronomy which is now receiving greater attention than the study of the spectra of the stars. Dr. Henry Draper was the first to photograph the lines in a stellar spectrum, although Sir William Huggins had already obtained a mark from the spectrum of Sirius, and later was the first to publish his results in successfully photographing stellar spectra. The untimely death of Dr. Draper, in the midst of his work, led to the establishment at Harvard of the Henry Draper Memorial. For nearly thirty years Mrs. Draper has maintained an active interest in this work. By placing a large prism over the objective of a telescope, the light of all the brighter stars in the field is spread out into spectra, so that instead of photographing the spectrum of one star at a time, as with a slit spectroscope, as many as a thousand have sometimes been taken on a single plate. Such photographs, covering the entire sky, have been taken with the two 8-inch doublets already mentioned. A study of the spectra thus obtained enabled Mrs. Fleming to discover many hundred objects whose spectra are peculiar. Among them may be mentioned 10 of the 19 new stars known to have appeared during the years in which she was engaged in

this work, while five of the others were also found at Harvard by other observers. She discovered more than two hundred variable stars, 91 out of the 108 stars of the very peculiar fifth type, and showed that these objects occurred only very near the central line of the Milky Way. During the last two or three years a great demand has arisen for the class of spectrum of large numbers of stars. The Harvard photographs show the class of spectrum of nearly two hundred thousand stars. Miss Cannon has, accordingly, undertaken to prepare a catalogue of these objects, with the result that she has already classified about one hundred and fifteen thousand spectra, covering more than one half of the sky. The work is progressing at the rate of five thousand stars monthly, and the results will fill seven of the large quarto *Annals* of the Harvard Observatory. The organization of this work has required the most careful application of the principles of "scientific managment."

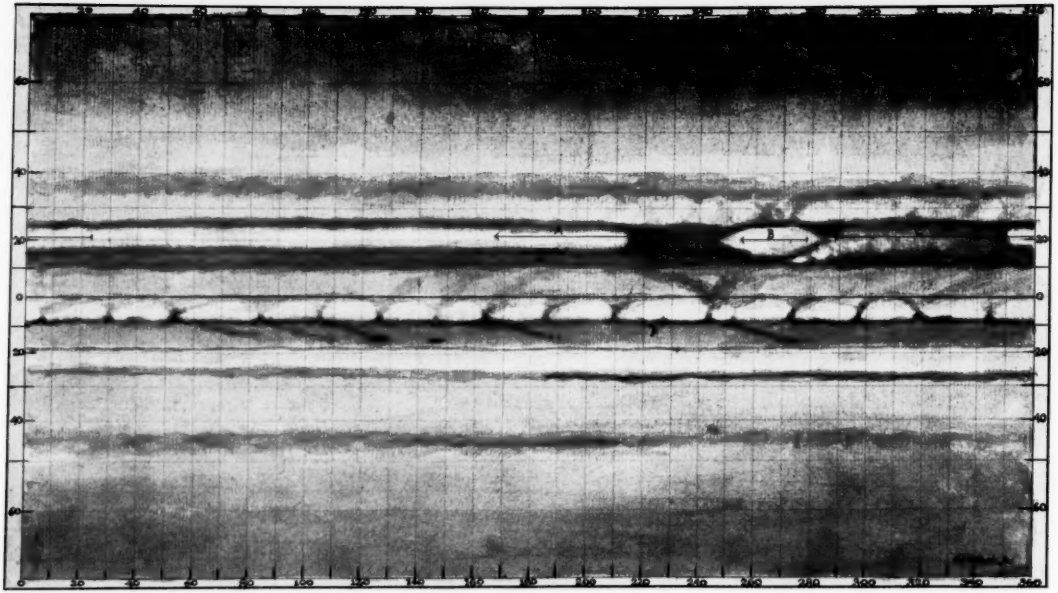
One of the most important results derived from the Harvard photographs was the discovery that in certain spectra the lines were alternately double and single. This, and the discovery by Vogel at Potsdam that the lines of the variable star Algol continually changed their position revealed the existence of spectroscopic binaries. No department of astronomy is receiving more attention, at the present time, than these objects, and in general the motion of the stars in the line of sight. The Lick, Yerkes, Greenwich, Potsdam, Bonn and Ottawa observatories are only a portion of those directing a large part of their energy to this subject.

One of the most important generalizations of recent times is the discovery by Professor Campbell that the velocity of a star depends upon its class of spectrum. The proper motion of a star was similarly found by the late Lewis Boss to be dependent on the same quantity.

In conclusion, the United States has attained an enviable position in the newer departments of astronomy. Can this be maintained? In Europe, especially in Germany, observatories and instruments of the highest grade are now being constructed, the government furnishing appliances with the most liberal hand. Perhaps the most promising sign for the future is the friendly coöperation of American astronomers, which has never been more marked than at the present time.

The possibilities of work are now greater than ever before. A small fraction of the effort expended in teaching science, if devoted to its extension and progress, would fulfil the objects of the American Association for the Advancement of Science.

PLATE V



MAP OF JUPITER

Compiled from micrometer measures, drawings and sketches made in July and August, 1913, at the Daniel Scholl Observatory.

Drift, Apr. 6–Nov. 20;—A, pD. B, RS. C, fD. D and E, Black spots, July 14–Sept. 13, System II. F, NEB bays, Aug. 21–Sept. 13, System I.

CONDITIONS ON JUPITER IN 1913.

A. THOS. G. APPLE.

The planet was observed here on 74 nights from February 13 to November 22, inclusive. Seeing in the main was fair to good.

Micrometer measures were taken on all but two or three nights to determine the latitude of belts and the meridian passage of various markings. The coördinates of the projections of markings and belts on the fundamental plane thus obtained were reduced to jovicentric latitude and longitude according to Witmell's formula for latitude* and a formula of our own for longitude.

A careful watch was kept upon the RS (Red Spot) and the pD and fD (preceding and following end of the S. tropical disturbance) and their drift. The NEB (N. equatorial Belt) was also followed in order to watch its development and determine its rotation time. Transits, occultations, and eclipses of Satellites and transits of their shadows were noted as they came within our range. The motion of Jupiter in relation to the two stars occulted during the season was carefully measured and the emersion of the second star was observed. The other occultation happened when the planet was not visible from this observatory.

The colors of the planet were also noted from time to time.

Belts.

The S. Temperate belt was always seen though it was not so prominent as it was during last season. The whole region of the S. hemisphere seemed to have been more quiet, the region of disturbance apparently having shifted northward.

The double S. equatorial belt was the most conspicuous feature, as it has been for quite a number of years past. The zone filling its southern half has continued in its abruptly broken condition, the interrupted ends which bound the S. Tropical disturbance remaining sharply marked. Twenty-four measures on the preceding end and twenty-four on the following end were reduced to longitude. The results show that both extremities have continued slowly drifting. The longitude of the preceding end on April 25 was 233°.67 and on September 13, 190°.17, a

* Jour. B.A.S. xxii, 1, p. 27.

drift of 43°.5 in 141 days or 9°.56 in a month of 31 days, which would indicate an acceleration of 12ˢ.73 on the period of System II. The longitude of the following end on March 11 was found to be 28°.89. About June 10 it passed the zero meridian and measures on September 11 yielded a result of 319°.80; a drift of 70°.09 in 184 days, or 11°.81 per month, showing a rotation acceleration of 15ˢ.36 upon that of system II. According to these the drift of the following end has been slightly in excess of that of the preceding end, indicating a slow shortening of the length of the disturbance. The drift of the RS has been sensibly smaller. Its longitude as determined April 30 was 273°.46, and Sept. 11, 260°.11; a drift of 13°.35 in 132 days, 3°.13 per month, or an acceleration of 4ˢ.07 upon System II.

Two black spots or stripes were observed (first June 7) on the north border of the zone whose truncated ends bound the S. Tropical Disturbance (which will be denominated the S. Tropical zone). These spots, a few degrees long, were quite narrow—no more than lines. We have designated them A and B. Their rotation period has been slightly less than System II. On the 28th of July the longitude of B was found to be 223°.10 and on September 25 it was found to have crossed the interval between the pD and the RS and was in close contact with the latter and showed a longitude of 239°.59. Drift + 16°.49 in 58¾ days, 8°.70 in 31 days, or a retardation relative to System II of 11ˢ.52 per rotation. The other spot preceded B by about 36° or 37°. Its rotation period seems to have been the same. We have here the case of spots slightly nearer the equator with a slightly slower rotation than markings in higher latitude, viz; the ends of the disturbance.

The N. equatorial belt has been the scene of the greatest activity during this apparition. The lengthened spots noted in the latter part of the last apparition were seen again as soon as observations began in February. The spots were larger, darker and longer, however. The peculiar appearance of the N. equatorial zone, broken into oval patches of white, figured in Mr. Wilson's drawings in a recent number of Popular Astronomy, was first noted on the evening of July 3. Eight sketches were made during June, on some of the occasions with exceptionally good seeing, but nothing was noted.

This configuration of the Equatorial belt has continued unchanged ever since. There has been evidence of a gradually retarded rotation in the N. Equatorial belt as the latitude has increased. On April 25 each spot or "bay" was accompanied by a fainter spot about 6° farther north. As time went on these seemed to fall behind the bays in longitude, while faint spots breaking out in between fell behind to a less extent, so that by May 2 they seemed to form oblique lines trailing back sp to nf. Besides this it was found that a spot in latitude +13°.63 ±.22

(mean of three nights) transited on August 16 at 11:11 (a longitude of 121°.56), August 19 at 8:39 (longitude 120°.32) and September 2 at 10:2 (longitude 113°.90). This would indicate a retardation on System II of 18°.56 per month of 31 days or a rotation period of $9^h\ 55^m\ 55^s.4$.

Red Spot.

The red spot was seen here first on April 6, already well advanced in the dark region of the S. Tropical Disturbance. Its shape has been strikingly like a dirigible balloon with pointed ends. Its length (probably on account of the pointed extremities showing to greater advantage against their present dark background) has been somewhat longer than during the former apparition. The mean of measures on seven nights is 35°.60 ±2° as against 26°.3 last year. Its color has been white, scarcely distinguishable from the color of the zone bounding (p and f) the Disturbance. Up to the latter part of June the surface of the disturbed area has been almost uniformly dark whenever seen, except a faint brightening, with vague configuration following the RS. This, early in July, became concentrated in a small white spot nf the RS, which with the white portions immediately following streamed out in a sf direction, suggesting very strongly a drift from the more central regions toward a narrow channel between the RS and the equatorial zone bordering it on the north. I could never be sure of any passage of material through the channel. The configuration was first sketched June 17 as removed some little distance from the RS, again July 3 as having advanced considerably, and being involved in the space between the RS and the zone to the N. Its color had become quite brilliant. At first it showed an unbroken line with its front brightest and quite conspicuous, but by August 25 it had broken up into at least four separate little spots that continued in the same line. The front spot at this time was almost abreast the center of the spot. It is this steady advance that causes us to suspect that in some quiet way the material has been conveyed to the preceding side of the RS, as the general material of the belt drifts past. The above described appearance was seen every night with one curious exception. On the 5th of August, between 10^h and 11^h, occurs the following entry: "The white spot just f the RS cannot be seen: it seems to have disappeared." The RS was then in full view with a quality of seeing rated 9-8 on a scale of 10. A peculiarity in the shape of the RS was seen in the shape of a very slight concavity on the nf side where it came into contiguity with the white mass just mentioned.

The RS has continued to drift relative to System II through the summer. Its longitude April 6 (computed from the longitude of its f end

and assuming half the average length to be 17°.8) was 274°.0; on September 27, 250°.38. This would indicate a drift of 4°.215 per month of 31 days, or a period of $9^h\ 55^m\ 31^s.28$.

This is slightly in excess of what seems to have been the drift during the period of conjunction. The longitude on 1912 October 18.4625, G.M.T., was 289°.8; on 1913 April 6.9050, G.M.T. it was 274°.0, a drift of 15°.8, or 2°.8737 per month, corresponding to an acceleration of $3^s.81$ or a rotation period of $9^h\ 55^m\ 33^s.06$. A slightly different result is yielded by the following solutions:—

			Cor. for light time
Transit of RS Oct. 18, 1912,	$6^h\ 0^m.6$ L.M.T.	$11^h\ 5.9^m$ G.M.T.	$10^h\ 17^m.0$
" " " Apr. 6, 1913,	16 38.6 "	21 43. "	21 1 .4

Interval of time 170.4475 days = 4090.74 hours.

From transit of RS April 30 and May 5 a provisional period of 9.9235 hours is obtained. $\frac{4090.72}{9.9235} = 412$ to the nearest digit. But the Jovicentric longitude of the earth has changed from 117°.96 on October 18, 1912 to 151°.00 on April 6, or an advance of 33°.04. Now 412 rotations = 148320°; adding 33°.04 gives 148353°.04, which is the angular sidereal arc passed over in the given time and 148353°.04: 360°: :4090.74h: X hours, when X hours equals the rotation time. Whence X equals 9.92677 hours, or $9^h\ 55^m\ 36^s.37$.

Colors.

The colors of the planet have shown a considerable change. Notes of the colors were taken on a large number of nights extending back to April and on all occasions it was seen that there was less of the pink color in the S. belt, and more in the northern. The southern part of the S. Temperate belt was sometimes entirely without the pink tint, though on all occasions the N. portion and the S. Equatorial belt were pink, with an apparent tendency to overflow the color upon the Equatorial Zone. The color of the N. Equatorial Belt was always the most decided and its northern boundary was quite distinct—a thin line of a belt only a couple degrees north of it always appearing of the olive-gray color that has always distinguished the polar areas. After the middle of October the pink color was reduced to a narrow line bordering on the NEB on its northern side, while the belt itself was reduced in width to little more than a line. The white ovals also lost much of their distinctness and showed a tendency to break up.

Occasionally shadowy spots appeared in the narrow and faint belts north of the NEB but they were so indistinct and so fugitive that no account could be kept.

It was noted also that the knots or bays on the S. border of NEB were frequently decidedly more conspicuous when on the meridian, growing dim more rapidly than the obscuration of the Jovian atmosphere would lead one to expect after passing the meridian.

The following determinations of longitude of the RS, pD and fD were made:—

RS		h	pD		h	fD		h
Apr. 6,	291.8	f end −20.1	Apr. 25,	233.7	− 0.5	Mar. 11,	29.9	+15.9
Apr. 25,	257.0	p end − 5.8	May 2,	223.1	−10.1	Mar. 16,	27.6	+ 1.9
Apr. 30,	273.5	cen. − 4.6	June 10,	221.0	−31.2	Mar. 28,	29.4	− 2.4
Apr. 30,	260.0	p end − 6.2	June 12,	217.1	−16.3	Apr. 7,	23.7	−31.9
May 5,	271.9	cen. − 2.3	June 15,	215.1	− 1.2	Apr. 21,	15.9	− 9.2
June 8,	266.6	" −14.0	July 1,	213.8	+25.5	May 18,	7.5	+16.6
June 10,	267.1	" +10.2	July 2,	212.4	+20.7	May 25,	8.0	+ 7.4
June 15,	266.8	" − 0.1	July 4,	213.2	−13.1	June 6,	4.5	+ 0.7
June 18,	262.3	" + 0.6	July 7,	211.2	− 8.9	June 13,	355.6	+ 0.1
July 2,	265.3	" +18.1	July 14,	205.0	+ 6.8	July 6,	346.8	− 8.7
July 3,	267.0	" −22.2	July 19,	205.1	+ 7.6	July 7,	345.0	+ 7.6
July 4,	265.4	" + 1.6	July 21,	204.0	+12.7	July 10,	343.2	− 1.9
July 7,	263.7	" +13.6	July 28,	202.7	+ 7.4	July 22,	340.2	− 3.4
July 15,	266.5	" −13.9	Aug. 5,	200.8	− 7.9	Aug. 11,	332.8	−32.7
July 21,	265.3	" −15.5	Aug. 7,	190.6	+ 9.8	Aug. 13,	327.6	− 8.7
July 22,	265.7	" − 6.6	Aug. 14,	197.3	+28.0	Aug. 20,	328.1	−17.2
Aug. 5,	254.7	" + 7.0	Aug. 19,	196.6	+ 2.8	Aug. 23,	326.5	+ 2.7
Aug. 8,	261.9	" − 0.5	Sept. 10,	189.2	+ 4.4	Aug. 25,	323.3	+ 4.7
Aug. 15,	258.9	" + 3.1	Sept. 13,	190.2	−12.9	Sept. 4,	320.5	− 1.5
Aug. 20,	259.5	" −22.4	Oct. 14,	184.7	+18.2	Sept. 9.	319.3	−13.1
Sept. 8,	259.7	" −20.8	Nov. 5,	177.7	−24.7	Sept. 11,	319.8	− 2.6
Sept. 11,	260.1	" +28.2	Nov. 7,	171.1	+20.6	Oct. 27,	302.9	−11.3
Sept. 13,	251.0	" + 8.3	Nov. 12,	171.1	+16.7	Nov. 6,	296.3	−34.2
Sept. 25,	252.9	" − 3.2	Nov. 17,	167.9	−10.7	Nov. 20,	288.4	− 3.1
Sept. 27,	250.4	" + 6.4						
Oct. 15,	254.5	" −29.3						
Oct. 22,	251.8	" −26.4						
Oct. 29,	251.0	" − 4.0						
Nov. 5,	246.9	" +17.6						
Nov. 20,	244.2	" −28.6						
Nov. 22,	241.7	" +10.9						

The column h is the angular distance of the marking from the Jovicentric meridian at the time of measurement. In addition to these, measures of spots on the NEB were made on 67 nights. The longitudes were at first computed by System II. This indicated, from a number of pretty certainly determined identities on different nights, a very much greater rate of rotation, and the longitudes were subsequently referred to System I, with the result that the rotation period appeared to be slightly less than those of System I: $9^h\ 50^m\ 6^s.55$. This is the mean of five spots measured in September and October at intervals of 21 and 25 days. Measures on 70 nights were made for position angle of the belts. If the axis of the planet was concentric with the general belt system, these measures, referred to the axis, show a remarkable agreement with the position angle given in the Ephemeris of the Nautical Almanac, while at the same time the differences are significant.

As a check on our measures we computed the amount of compression as a by-result of each measure, as well as the semi-diameters. The mean of 136 measures (each consisting of ten separate settings) of the equatorial semi-diameter,—corrected for phase and reduced to mean distance, is 19″.3727 ± 0″.0163. The mean of 100 measures of compression (each consisting of 10 settings upon each diameter) is 1/14.855 ± 1/12000, or by decimals .067178 ± .000084. The worth of these, results is purely as a check upon the actual character of the measures from which they are derived. Each value of semi-diameter was derived from the half sum of the distances of a particular spot from each limb and being made up therefore each of two different measures it would include within itself the errors of both. But as the compression is an exceedingly sensitive result, so to speak, in the sense of magnifying the errors of measurement, its near agreement to the accepted value of Jupiter's compression (1/16) would tend to show that the measures have been reliable to a fair degree. On 19 occasions estimates of time of transit were made at the same time as measures were taken. The results show that the amount of divergence is not a function of the angular distance of the marking from the meridian, E—M (estimate minus measure) being small when distance was great as often as it was the reverse. There were no discrepancies greater than 13 minutes, and five less than one minute, or more exactly,

Discrepancy	No.	Discrepancy	No.
between 0 and 1 minute	5	between 5 and 6 minutes	1
between 1 and 2 minutes	2	between 6 and 7 minutes	1
between 2 and 3 minutes	2	between 7 and 8 minutes	1
between 3 and 4 minutes	3	between 8, 9, 10 minutes	0
between 4 and 5 minutes	1	between 10,11,12,13 minutes	1 each

Daniel Scholl Observatory,
Franklin and Marshall College,
Lancaster, Pa.

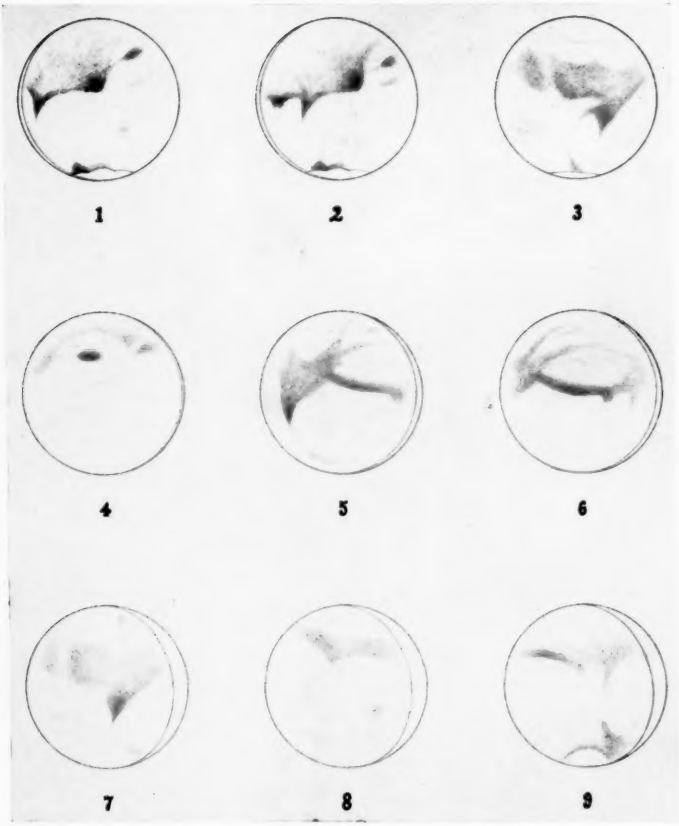
KING SIRIUS.

Hail!—Monarch of the suns of night!
King Sirius—supernal gem—
Grand Canis Major's diadem!
Greetings again, O Beacon bright,
A blaze with God's celestial light,
Welcome to Earth, to northern ken,
And shine upon our sons of men;
Greeting to thee, thou gorgeous Star,
Unchanged you were, unchanged you are,
The same resplendent friend afar;
O sun of suns, in winter skies
You reign like glimpse of Paradise,
So royal, grand, divine and bright—
Hail! Hail to thee, O King of Night!

CHARLES NEVERS HOLMES.

Northampton, Mass.,
Plymouth Inn.

PLATE VI



DRAWINGS OF MARS AS SEEN WITH A FIVE-INCH TELESCOPE IN 1911 BY D. HENRY SCARLETT.

MARS WITH A FIVE-INCH TELESCOPE.

D. HENRY SCARLETT.

Amateur astronomers and others interested in astronomical matters have often inquired as to what one might expect to see of Mars with a common telescope. With the hope of supplying some information upon this subject, I have prepared this account of my observations of that planet at the opposition of 1911-12.

At that time I had opportunity to make thirty observations of Mars. This account includes nine drawings of my best work. I made these observations with a five-inch Clark telescope mounted on a portable equatorial. This instrument has slow motion in the right ascension but is without circles or a clock attachment.

Referring to the drawings, No. 1, observation of Nov. 5, 1911, shows the Aurorae Sinus near the center of the disk. This region was quite dark in color, especially in one spot and was sharply defined on its lower or northern edge. The Solis Lacus, which has just entered upon the disk, was quite dark and not difficult to identify. The Nectaris canal was visible. It appeared as a fine, shadowy line, hard to see, but distinct with attention. With the exception of the point, the Margaritifer Sinus was very sharply defined and as dark as the Auroræ Sinus. The edge of the north polar cap shows at the lower edge of the disk. Mare Acidalium was quite conspicuous on the edge of the cap and at the left. The dusky spot, about midway between the Auroræ Sinus and the polar cap, is Lunae Lake. This marking was very faint and was seen by glimpses only.

In drawing 2, observation of Nov. 8, 1911, we have about the same presentation. The seeing on this date was excellent and eyepieces of 188 and 250 powers could be used. With 188 power, the markings were very sharply defined and I was able to identify them almost at a glance. The Sabaeus Sinus was the darkest marking and with steady gazing, I could define its two points. The Nectaris canal was again visible. After I had watched the planet carefully for a few minutes, I became aware of two very faint, brownish streaks crossing the disk. They were not very difficult to see. One, the Jamuna canal, extended from the Auroræ Sinus to Mare Acidalium; while the other, the Ganges, started at Aurorae Sinus and disappeared when about midway across the disk.

Drawing No. 3, observations of November 22, 1911. In this presentation, the Syrtis Major was the darkest and best defined marking visible. The point was quite sharp. Curving to the left and downward from the left edge of the Syrtis Major, was Lake Moeris and the begin-

ning of the canal which connects it with the wedge of Casius. This canal can be seen quite plainly with a five-inch telescope at certain times. Lake Moeris was quite distinct. Casius could be seen distinctly, extending upward from the north polar cap. The Syrtis Minor was quite dark, especially near Hesperia. Hesperia was not very distinct. It appeared as an ill defined, light streak between Syrtis Minor and Mare Cimmerium. Near the left limb are two very faint streaks, which are connected with the canal system around Elysium.

Drawing No. 4, observation of December 10, 1911, shows the Solis Lacus as a very dark and conspicuous oval spot, near the center of the disk. The Nectaris canal was again visible. Mare Sirenum was just entering upon the disk and was almost as dark as the Solis Lacus. The bridge which connects the Aurorae Sinus with the Aonius Sinus was quite faint, but not difficult to see. A faint streak was visible directly below the Solis Lacus. It was difficult to see, but plain with attention. This streak is a small, narrow, three-cornered dark area which lies between three canals and can easily be found on any good map of Mars. The markings of this presentation look somewhat like a large eye.

Drawing No. 5, observation of December 24, 1911. The Syrtis Major, near the limb, was very dark and conspicuous. The narrow strait, which connects it with the Sabaeus Sinus, was a little lighter in color, but very clearly defined. I have found that this region is almost always easy to identify. The Sabaeus Sinus was just entering upon the disk and was not very distinct. The Nilo-syrtis canal was quite easy to see and appeared as a dusky line, connecting the point of the Syrtis Major with a faint area just below.

Drawing No. 6 shows the same presentation at about one and one half hours later on the same date. The Sabaeus Sinus has become very distinct and its two points could be defined. The seeing on this date was excellent and the markings were much darker and more distinct, on the whole, than I ever saw those of the moon with the naked eye.

Drawing No. 7, observation of February 6, 1912, shows about the same presentation as that of November 22, 1911. The Nilo-syrtis canal was visible, but I could not see Lake Moeris. The Syrtis Major was quite dark in color and especially so near the point.

Drawing No. 8, observation of February 16, 1912. Mare Sirenum and Mare Cimmerium were both easy to define, although neither was very dark or sharply outlined. Sirenum was the darkest. At this date the planet was about 100,000,000 miles from the earth. Trivium Charontis showed as a dusky spot, at the right and a little more than half way down the disk. When well situated for observation and when Mars is near to the earth, Charontis can often be defined beautifully. By glimpses, several faint, dusky lines could be seen extending out on all

sides of Trivium Charontis. Several more could be glimpsed, extending downward from Titanum Sinus or the lower point of Mare Sirenum. I could not determine the exact position of these canals because they were visible only by fleeting apparitions. I have indicated their position in the drawing as well as I could.

Drawing No. 9, observation of April 10, 1912, will show that even when Mars is very far from the earth, some markings may be seen. At this date, the planet was about 150,000,000 miles distant. The north polar cap was turned somewhat to the earth and was surrounded by a very faint, dark streak, as it usually is when melting. This streak was very hard to see. Mare Acidalium was quite distinct and a very faint, narrow streak could be seen, connecting it with the point of the Margaritifer Sinus, above. This streak was probably connected with one of the canals. The Sabaeus Sinus is just to the left of the center of the disk and is rather faint. The narrow strait which joins it on the left, was the darkest marking visible.

In conclusion I would like to say that I do not consider the canals of Mars very difficult to see with a five inch telescope. Much depends upon the clearness of the atmosphere, the observer's knowing when to look for the canals and his persistance and care in watching, They are often seen best when the northern hemisphere of the planet is turned toward the earth and not necessarily when the planet is nearest. During an opposition, there are nearly always times when the atmosphere is in good condition for seeing and if the observer watches for fleeting apparitions, he will surely catch some of the canals and especially in the region below Mare Sirenum and around Trivium Charontis. The Jamuna, Ganges and Nilo-syrtis canals are quite easy and may often be seen by direct vision.

The present opposition and the next ought to offer good opportunities for seeing canals.

The markings of Mars are usually soft on the edges like the markings of the moon appear to the naked eye; but there are some, which at times, are quite sharp in outline. About two-thirds of the time I can use an eye-piece of 188 power to an advantage and sometimes I can use 250 power. I have found but few nights, suitable for making observations, when it was impossible to discern any markings and at about one observation out of three they came out quite distinctly.

If one wishes to see the colors to the best advantage, the planet should be observed just before sunrise or just after sunset, while the sky is light. Then, if the seeing is good and Mars is near to the earth, the markings will show greenish tints. The desert regions will show a quite strong reddish color, especially near to the center of the disk and the polar cap will appear more distinct and a clearer white.

Lowell, Mass.

THE NORTH POLE.

WILLIAM F. RIGGE, S.J., F.R.A.S.*

[*Continued from* Vol. XXI, *page 409.*]

The axis of revolution about which the earth revolves is not fixed in the earth, as one would naturally suppose, and as even scientific men supposed until the contrary was proved. It moves about in a very complicated manner. The poles shift on the ground in a space about sixty feet in diameter. There are two components to the motion. The first has a period of one year, and moves the pole of revolution in an ellipse, whose major axis is about twenty-eight feet, and minor axis about eight feet. The center of this ellipse is a certain fixed point termed the pole of symmetry or the pole of figure. The second component moves the pole of revolution in a circle about this same pole of symmetry as a center. This circle has a diameter of about thirty feet, and the period is 428 days. Both motions are in the same direction, from west to east. The ellipse swings round slowly in the opposite direction at the rate of about five degrees a year, and there seems to be another variation with a period of about 436 days.

The results have been obtained by astronomers without leaving their observatories, by observing the variations of their latitudes. Places on opposite meridians behaved oppositely; when one approached the pole by increasing its latitude the other departed from it by decreasing its own the identical amount. In this way it was proved that the continents did not sway to and fro, but that the axis of revolution itself shifted in the earth.

This splendid achievement of modern science would receive much confirmation and would be prosecuted with less labor and with better results by an extended series of observations made near the poles themselves. This would, of course, require the refined instrumental outfit of a large and fixed observatory.

The occupation of the pole by a fixed observatory would have no other astronomical advantage. The apparent diurnal motions of the heavenly bodies as seen from the poles are known to every elementary student. The mounting of the instruments would give rise to no special theoretical or mechanical problems. The advantantage of the long night of six months, which the twilight would cut down to about three, would

* Professor of Physics and Astronomy, The Creighton University College of Arts and Sciences; Director of the Observatory.

be offset by the at least equally long day. Observations by day or by night would most probably be much interfered with by the weather. So that as far as the observation of the heavenly bodies is concerned the poles are rather at a disadvantage, and this is the more because only half of the heavens is visible at each of them.

The magnetism at and near the poles is another subject upon which information is desirable. We know that the earth has two magnetic poles and that these are at considerable distances from the poles of revolution, and moreover are not at the extremities of the same diameter.

The magnetic elements of the earth are three—declination, inclination and intensity. Declination is another name for the variation of the compass, and is the angle the magnetic needle makes with the true meridian. Inclination is the angle the dipping needle makes with the horizon. It is measured by supporting a magnetic needle on its center of gravity, placing it in the magnetic meridian and leaving it free to turn in a vertical plane. At the magnetic poles the dipping needle dips ninety degrees; that is, stands perfectly upright. At the magnetic equator, which for obvious reasons cannot coincide with the astronomical equator, the dip is zero, and the needle is horizontal. And, lastly, the third element is the intensity, which means simply the strength of the earth's magnetism at any place.

These three magnetic elements, especially the declination, which is of such vital importance in navigation and travel generally, have been pretty well determined all over the earth. This is true to the extent that they may be approximately predicted for places in which they have not yet been actually measured. I say approximately, because actual magnetic surveys have disclosed many important errors. And moreover, all the three elements are subject to accidental and periodic variations. The accidental variations are called magnetic storms and periodic ones are divided into diurnal, annual and secular changes. Explorers cannot, therefore, trust the compass implicitly. On the other hand, the magnetic elements they observe add a welcome amount to our store of information.

As one of the magnetic poles of the earth has been well located and been actually occupied by explorers, we have a somewhat definite knowledge of its magnetic elements. But the whole scientific world is much interested to know what the magnetic elements of the poles of revolution are and to what variations they are subject. Fixed magnetic observatories at all the four poles, the two magnetic and the two revolutional, is one of the day dreams of science.

The meteorological conditions at the poles claim their share of scientific interest. Only one day and one night in the year must cause most abnormal conditions of the weather. The cyclonic, that is rotary, whirl

of the atmosphere would seem to be most pronounced near the actual center of revolution. The extremity of the cold, followed by the long insulation, is another exceptional feature. A meteorologist would have no rest until he also could erect an observatory at the poles.

We can find space here only to hint at the other sciences that would benefit greatly by polar exploration, such as geology, geography, zoology, botany and many others. The polar sea would probably be as interesting as the land, in its currents, life, temperature and other features.

But enough has been said to show that the actual occupation of the poles would add enormously to the advancement of science.

A WRONG ATTITUDE IN AMATEUR ASTRONOMY.

FREDERICK C. LEONARD *

During the years I have been president of the Society for Practical Astronomy I have had many very interesting experiences with amateur astronomers. I have found that, taking them as a class, they are probably far more enthusiastic than most other kinds of amateurs usually are, and, as a general rule, that they are eager to produce and contribute results of real value to their chosen science. Many if not most of them seem willing in fact, with the time and means at their disposal, to do all they can to coöperate with others and to aid in large pieces of work that are really important to astronomy. There is, however, with some amateur astronomers a sort of spirit of indifference and even dislike toward engaging in anything that will make their efforts worth while. Unfortunately, in spite of the foregoing facts, this condition is perhaps more prevalent than it ought to be, especially at the present time, when there are so many excellent opportunities by which an amateur can make his time and pleasure in the observation of the heavens of genuine merit to science.

No doubt all amateurs, in taking up astronomy, take it up originally and primarily for pleasure, recreation and interest. This is natural, and to be expected. Astronomy should not, however, even if studied at first for any of the aforesaid reasons, remain, to the amateur who is sufficiently advanced and experienced, merely a means of obtaining personal pleasure; it should contain, even for him, a greater and more dignified signification. Yet how many amateurs are there who are content simply to entertain themselves and their friends with the teles-

---

* President of the Society for Practical Astronomy, etc.

cope? I regret to say that there are too many. Just recently I had an experience with an amateur that may be of interest to relate here. I had occasion, upon knowing previously that the gentlemen in question was one who might be called an amateur astronomer, and was provided with both a telescopic and a photographic outfit, to invite him to join the Society for Practical Astronomy, and particularly our Photographic Section (inasmuch as he was in a position to do photographic work so well). He replied rather dryly to my invitation that he was one of those persons who do not care to join scientific societies, as he did not have the time to contribute anything in the way of written articles, but he would feel, if he joined the S. P. A., as though it were his duty to do something in that line. I endeavored to explain to him that such would not be expected if he did not have the time, and, if he would send in the results of his work to the director of the Photographic Section, the director would gladly attend to the proper utilization and publication of them for him. He told me that he would consider the matter, and, the result of the conversation was, as might be expected from the beginning, that he preferred to remain alone and cultivate astronomy for his own pleasure and amusement. Upon inquiry, I learned that this gentleman has a 4-inch refractor, permanently mounted under a revolving dome, and, in addition to this, a 4-inch photographic lens by Brashear—an outfit which any amateur might prize and justly be proud of, and which, if in the proper hands, could yield results of almost unlimited worth in more than one branch of observation. I cite this case merely as one typical of many that I have personally encountered since I began, some years ago, to do my part in the movement to unite amateur astronomers and incite them to work and to observe systematically. I may state that the gentleman alluded to is not by himself, but is representative of a singularly large number of amateur astronomers all over this country who, though they are able and willing to take the pains and spend the money required to build up a rare astronomical equipment, yet, at the same time, are unwilling to use that outfit in such way that it shall be of utility for anything outside of their own personal entertainment. I know of several such cases in one city, and know of a certain amateur who has a fine observatory, a magnificent large refractor with a varied stock of eyepieces and other accessories, a micrometer, a camera, a spectroscope,—in short, everything that one could want—an equipment that would indeed be a credit to any college or university, who probably has never made or published a single observation of scientific value, although he has been interested in astronomy, I understand, most of his life!

A colleague of mine in the Society for Practical Astronomy, the director of one of our ten Observing Sections, in writing to me some time ago,

summed this sort of thing up very tersely as follows: "Although several of the members possess moderately large instruments (six to sixteen inches aperture) and are apparently in position to do useful work, they are the very ones from whom one can expect the least—not because they are active in some other branch of observation (for they are not); they merely gaze about, hither and yon, looking for curiosities, I suppose, ordinary 'sky tramps,' I fear. If they only had the energy and enthusiasm displayed by some of the members of the S. P. A.,..... something interesting and useful could be accomplished. Alas! their instruments, I'm afraid, are regarded more or less as scientific toys to play with occasionally." This criticism, or rather complaint, is one that could be made of many amateurs, especially of one like the person just mentioned. The same correspondent, in a previous letter to that from which the above extract is taken, almost amusingly, but only too truly, again writes, "It appears, sometimes, that enthusiasm for work varies inversely with increase in instrumental means; 'the little fellows' seem more eager to do something than those with the big telescopes!" While it might be going a bit too far to say that those amateurs with small telescopes are doing the most for astronomy, yet it is doubtless the truth that those who are the fortunate possessors of the large ones in a majority of cases are certainly not doing by any means all that they reasonably could do, and, moreover, upon first blush, it would really appear as though the man with the little instrument were contributing the more of the two.

Perhaps the foregoing examples (which I could easily multiply) are sufficient to illustrate what I am trying to bring out—the *wrong* attitude many amateur astronomers take. Since there is so much ultimately to be done in astronomy, and since there is so much that the amateur can do with profit for the science, there is no reason why, with the many ways open for him to make his efforts of advantage and the opportunities afforded for his encouragement, he should be content to continue amusing himself and making desultory and worthless observations. If by joining some society, or by putting himself into touch with some observatory, and doing his work so that it shall be valuable, and placing it where it can be made so, is there any really good reason why the amateur of today should shrink from these opportunities, simply because he is afraid that he will thereby place himself under some imaginary obligation? No organization or institution will require or expect of any amateur more than he can do in the leisure time he may devote to his favorite pursuit after business hours or vocational duties. Many amateurs have a very erroneous idea of what is meant by coöperation, and that, very likely, is what deters them from entering in upon it more freely. Many hold the opinion that if they join a society, such as the Society for Practical Astronomy or the British Astronomical

Association, or if they coöperate with some observatory, like the Harvard College Observatory, they will be required to give all their services and an unreasonable amount of time to the work. For the benefit of those who are laboring under this misapprehension, and who have this idea, allow me to correct it once and for all time, and assure them that it is entirely unfounded.

So much has been written of late years in this journal and in other astronomical publications, concerning valuable work for the amateur that I need not digress into that subject here. It will suffice to repeat that there is plenty of such occupation for everybody inclined to take it up, and organizations and institutions that are only too happy to have the coöperation and receive the honest labors of even the humblest of amateurs. If the present article succeeds in instigating those who have telescopes and other astronomical apparatus to put them to use of real moment, and in impressing upon those who have been indolent or indifferent the value of coöperative study, and finally in correcting the wrong impressions concerning such, it will have admirably fulfilled its purpose.

I shall be pleased to hear from any amateur at any time if I can offer assistance or suggestions that may be of benefit to him in astronomy.

1338 Madison Park, Chicago, Ill.,
1914, January 1.

THE MIDNIGHT SKIES.

Alone with the stars at midnight,
Alone with the skies sublime,
With queens and the kings of ages,
With God and eternal time!

Alone in the darkling silence,
Alone with the heart of night,
When earth is a shrouded atom
Adrift amid gems of light.

Mid jewels that glow and glitter
Like fires a-blaze overhead,
Or sleepless eyes which are watching
Our world of living and dead.

Lo! Brightly some sun is blazing
Like beacon that burns on high,
And whitely a planet's mirror
Is shining amidst the sky.

King Sol from men's sight is hidden,
Queen night has dethroned the day,
And like some majestic river—
The maze of yon Milky Way.

Alone, alone with Creation!
On earth and her whirling sod,
Alone with the Laws of Nature,
With self and Eternal God!

CHARLES NEVERS HOLMES.

Templeton, Mass. Templeton Inn.

REPORT OF THE AMERICAN METEOR SOCIETY.

CHARLES P. OLIVIER.

While the year 1913 could hardly be called a favorable one for the average observer of meteors in America, on account of cloudy weather or moonlight near the maxima of most of the prominent showers, still the results of the work of our society are distinctly encouraging.

In 1911 with three observers 466 meteors were reported, in 1912 with five observers 970 meteors were reported, while in 1913 with five obsevers no less than 1277 meteor records were sent in. As is it quite probable that one or more reports may not have been yet received, this total may grow larger.

The list of members is at least twice as large as the number who send in reports. It is sincerely hoped that 1914 will see the remaining members take an active part in the work and also many new observers join the Society.

It is with special pleasure that attention is called to the splendid record of Mr. Nels Bruseth of Silvana, Washington. In the eight months of 1913 that he was a member he has sent in observations of 540 meteors made on 23 nights of regular work and many other nights of intermittent work. We especially welcome as new members for 1913 Rev. E. A. McDonald of Isabela, P. R., and Mr. B. H. Dawson of LaPlata Observatory, Argentine, both of whom have sent in excellent observations which are of special value from the southern latitudes of the stations.

It will be seen from the figures given above that some 2700 observations of meteors have been sent in altogether. Of these perhaps 70 per cent were actually charted. For the rest more or less complete descriptions are available. For about 300 only the rates per hour, with some brief notes, were given. The labor of working up the results from this great mass of material has fallen so far entirely upon the author. To date 40 parabolic orbits have been computed from the data mentioned and about 60 other radiant points have been measured. However, some of the maps have not been worked up at all so that it is safe to say that at least 80 radiants will turn out well enough fixed to have orbits computed.

Perhaps 50 other less certain radiants will be found. In addition there will be a great amount of valuable information as to the physical peculiarities of the meteors. The wide distribution of our observers also gives the chance to compare observations of the same date at far distant stations, as for instance about August 1, 1913. The table shows some interesting differences in the rates at the different places. We cordially invite any person in America, interested in meteors, to join

our Society. In the final publication of our results each person will receive the fullest credit for his particular share in the work, and, as no telescope is necessary, the observing of meteors is particularly adapted to amateurs who are really desirous of doing useful work but lack equipment.

TABLE SHOWING NUMBER OF METEORS OBSERVED.

Observer	Station	Date 1913 G.M.T.	Began h m	Ended h m	Interval	Obs'vd Meteors	Notes
Nels Bruseth	Silvana, Wash.	May 5	22 40	23 55	75	16	Very clear
		6	21 35	23 10	95	11	" " ex.10^m
		29	21 45	22 45	60	10	" "
		30	17 30	18 40	—	9	" "
		June 1	20 45	21 45	60	10	" "
		26	19 0	20 30	—	14	
	Index, Wash.	July 26	18 55	19 35	40	9	
		28	21 5	22 5	60	23	
		29	22 0	23 30	75	11	Clear ex. 15^m
		31	21 0	23 0	120	52	Very clear
		Aug 2	21 15	22 30	75	22	Faint haze 30^m
		3	18 0	18 20	20	9	
		8	20 5	21 5	60	25	Mostly clear
		27	17 45	18 45	60	27	Very clear
		Sept. 5	18 15	19 15	60	12	Clear
		6	18 30	19 55	85	24	Very clear
	Silvana, Wash.	29	17 35	19 30	115	20	Passing clouds
		Oct. 27	19 30	22 30	180	51	Clear ex. 15^m fog
		Nov. 2	18 0	20 0	120	42	Very clear
		Dec. 1	19 0	20 0	60	16	Very clear
		7	23 30	0 35	65	22	Slight haze
		8	23 20	1 0	100	36	Very clear
		20	17 30	18 0	30	5	Clear
		23	19 0	19 30	30	5	Clear
		Misc.				59	
A. P. C. Craig	Corona, Calif.	Aug. 10	21 5	23 15	130	71	Very clear
B. H. Dawson	LaPlata, Argentine	Aug. 1	14 10	18 35	145	46	Clear
		Misc.				2	
E. A. McDonald	Isabela, P. R.	July 29	18 0	20 0	120	47	Clear
		30	18 45	20 45	120	56	Very clear
		Aug. 1	18 30	20 30	120	15	" clear
		2	18 0	20 0	120	27	" clear
		4	18 50	20 50	120	46	" clear
		9	18 15	18 45	30	3	
		10	19 0	21 0	120	17	Clear
		11	20 0	21 0	60	21	Clear, dawn
		12	19 0	20 30	90	24	Clear
C. P. Olivier	Decatur, Ga.	Apr. 5	17 18	21 18	240	26	Fairly clear
		May 2	21 21	21 55	34	4	" clear
		3	20 48	21 49	61	14	Some twilight
		9	20 12	21 39	87	11	Some twilight
	Yerkes Obs., Wis.	July 27	16 13	18 35	142	14	Clear
		28	16 10	19 54	224	45	Moon last half
		Aug. 1	17 4	20 4	240	52	Clear
		4	17 3	19 39	156	50	Clear
		12	17 10	20 17	147	39	Clouds, haze at times
	Decatur, Ga.	Oct. 25	17 10	19 56	166	39	Fairly clear
		31	16 54	19 54	180	35	" clear
		Misc.				35	
				Total		1277	

Agnes Scott College.
Decatur, Ga. Jan. 3, 1914

MONTHLY REPORT ON MARS.—No. 2.

WILLIAM H. PICKERING.

On looking over some of his early drawings of Mars, made at Cambridge in 1890, the writer was gratified to find a few that clearly show some of the canals. These drawings were made shortly after the autumnal equinox of Mars, under conditions precisely similar to those obtaining at the present opposition, excepting that they are for the southern instead of the northern hemisphere. Some of the canals represented in these drawings were dark and very broad, which accounts for their visibility, at Cambridge. They should readily have been visible with seeing 6. Therefore observers in our eastern states should not be discouraged from looking for the canals at the present time, and it is possible that by careful watching they may see a few of them. Under favorable circumstances they may be seen with a 5-inch aperture.

In our last report we noted that the northern polar cap was gradually increasing in size as the winter progressed, exactly as it does upon the earth. By October 30, the beginning of the Martian spring, it had reached as far south as latitude 52°, corresponding to the latitude of England and of southern Labrador. Two nights later a considerable further increase occurred, large areas having been "snowed under," and it was found now to extend to latitude 42°. This proved to be its southern limit and maximum size, the corresponding equivalent terrestrial date being March 5.

It will thus be seen that the polar caps of Mars are less extensive than those of the earth. This does not necessarily imply a warm climate. It may be due entirely, to what we know to be the fact, that there is less water upon Mars. If there is less water, the snow caps would be thinner, and therefore more quickly melted during the daytime. This last addition to the snow cap may in fact have been a very thin layer,—just enough to cover the ground. Now oddly enough, we have some evidence to indicate that this was really the case although usually we do not attempt to gauge the snow fall of our neighbour.

Since the northern pole of the planet was inclined towards the earth at an angle of 9°, the observed outline of the snow cap was usually seen to be convex, but this night in spite of its greater size, the boundary line went straight across the disk till it reached the sunset terminator, the remainder of its course being hidden from view. Now the only possible explanation of this fact is that, along the central meridian

of the planet the edge of the snow cap was nearer to the pole than it was at the limb, that is it was nearer the pole at noon than at sunrise, in other words it was rapidly melting.

Unfortunately this explanation did not occur to the writer at the time, so that the next observation was not made until six days later, November 7, when the cap had retreated to latitude 59°. The mere fact of the retreat of the cap in six days through 17° of latitude, about 100 miles a day, is sufficient in itself to show that it could have been of very little depth, but however thin we assume it to have been, the amount of water liberated must have been enormous. The area uncovered was a trifle over five million square miles, or more than once and a half the area of the United States.

By November 26 the snow cap was materially reduced in size, its boundary being in a mean latitude of 67°. It had increased somewhat by November 28, reaching latitude 61°, but the whole disk was reported as hazy. A still further increase in size occurred by November 30, to latitude 56°, and the snow was now recorded as quite free from cloud. Again the boundary of the snow stretched straight across the disk from the limb, but this time it was seen to curve northerly as the terminator was approached. That is the boundary was nearer the pole at sunset than at sunrise. Another increase in the snow cap December 8, accompanied by the same phenomenon made it clear that a causal connection existed between the two, that we were really seeing the snow melt on Mars in the course of a few hours, and that the snow cap was really very thin at its advancing edge. This is of course what we should expect, but it is of interest as having been found without being directly looked for. At the end of the period considered in this Report, December 16, the boundary of the snow has receded to latitude 70°, the latitude of northern Alaska and of the north cape in the case of the earth. The equivalent terrestrial date is March 27. As the edge of the snow was usually sharp, although sometimes indented, as we shall later describe, it is probable that the precipitation occurs mainly at night.

The clouds along the limb continued to be a prominent feature during this period, though perhaps less so towards its close. They were sometimes irregularly distributed, but more often stretched in a band of gradually decreasing breadth from the south pole to a little beyond the equator, the north temperate and northern torrid zones showing the greatest number of clear mornings. On December 2 a belt of cloud stretching from pole to pole along the limb, reached 0.3 way across the disk towards the terminator, obliterating everything but the very strongest contrasts beneath it. Two days later a considerable increase in the size of the polar cap occurred, which increase continued for four days longer.

During the whole of this period there was a clearly shown southern cap, usually much larger than the northern one, and of constantly varying size and shape. Although often nearly as brilliant as that at the north, it was not white, but yellow, and towards the end of the period light green. Just when the change of color occurred is not recorded, and it was probably gradual. On December 4, the cap was painted in a drawing made at the time as bright yellow, while on December 12 it was painted light green. The green is possibly due to vegetation seen between passing clouds.

We are now at a very interesting period of the planet's year. When the snow was first detected at the north pole it was not bounded by a dark band, but this soon after developed, and increased rapidly in intensity. The band was by no means uniform in breadth however. On November 17 it increased fully 900 miles in width at the terminator, and not over fifty at the limb. It was moreover concentrated in four knots. The first of these appeared at the northern end of Amenthes on September 30 in longitude 240°, later shifting with the retreat of the snow to longitude 270°. At the next presentation on November 7 it had greatly increased in both size and density, stretching as far south as latitude 30°. It was the darkest area visible upon the disk, and was colorless, simply a dark grey, with no trace of green. At its southern end it was now joined by the two canals Eunostos and Amenthes, each about 250 miles in breadth and very dense. At the next presentation, December 10 to 15, Eunostos had disappeared, and was replaced by Hephaestus, which however was extremely faint. But the interesting feature of this presentation was that the dark area near the snow began showing a faintly bluish tint on December 10, which two days later was clearly marked, and continued so, as long as it was visible. Water had now clearly appeared in the liquid form, and was reflecting the light of the Martian skies.

The second dark spot to appear on the grey border of the northern snow cap was the Acidalium Mare, in longitude 35°, and was a much larger and more interesting object than its predecessor. When first detected, October 30, it was not very dark, indeed less so than the Sinus Sabaeus north preceding it, but the grey southern border of the snow cap was now of extraordinary breadth, fully 900 miles, reaching from one-third to one-half way across to the southern *maria* between Sabaeus and Aurorae Sinus, Straight across the intervening bright regions lying between the northern and southern dark areas stretched a faint broad grey band, as if the southern *maria* were being fed directly from the northern snows.

We have all of us watched a distant thunder cloud, with the rain falling from it in a dark uniform sheet. The appearance of this band

was just like the rain, if we can imagine the grey border of the snow cap sending the water due south a thousand miles to irrigate the southern *maria*. The preceding edge of the band lay nearly in the center of the disk, and was oriented precisely north and south as nearly as I could determine it. It seemed to be a development of the straight narrow band observed September 17, and recorded in the first Report. At the next presentation in November the band had swung around pointing to the southeast until it crossed the equator, when it turned and pointed southwesterly. East and west are here used in the astronomical sense, the reverse of their terrestrial meaning. This is precisely what it should have done if it were an atmospheric phenomenon controlled by the influences that affect our trade winds. Possibly its darkness was due to vegetation developed in a desert region by the current of moist air arising from the Acidalium Mare, and flowing across the equator to the southern *maria*.

It should be noted that neither the two bays at the following end of Sabaeus nor the Margaritifier Sinus had yet appeared. The coast line between 0° and 60° was nearly a straight line, and probably coincided pretty closely with the equator, or perhaps even a little north of it, but at the next presentation in November it had already receded southerly, and soon began to present its characteristic features. At our first view November 26, the broad border to the snow cap had entirely disappeared for half its length between Acidalium and the limb. Acidalium itself was well seen however, and appeared about as it did in October, except that it was darker. Its length north and south was 350 miles. From it proceeded two very faint curved canals. One of these reached Aurorae Sinus, and the other was headed towards Margaritifer, but only reached two-thirds way. These canals were seen November 30, and both were then complete. A third broad one extended from the forked bay of Sabaeus, which had now begun to develop, half way across to the northern dark regions surrounding the snow cap. These three canals were not seen clearly again, though the one leading to Margaritifer was suspected December 3. No trace of the broad band, other than the two canals, was found November 26, perhaps because it was too near the limb, but it appeared again two days later, reaching little more than half way to Margaritifer and following now the course of Nilokeras. Its breadth was about 700 miles December 1 and it bent sharply in the preceding direction, following the Ganges, advancing to within 250 miles of Aurorae, which it reached on the following day. December 10 there was evidence of the re-formation of the band between Acidalium and Sabaeus, but perhaps the most interesting changes in this region took place in Acidalium itself.

As we have seen, the dark portion of it November 26 was 350 miles in length. Two days later it measured about 500 miles north and south, while November 30 its outline was sharply defined and its length just 1000 miles. In the last two days Sabaeus and Margaritifer had also developed. The former appeared as a semicircular knob, the point of Aryn between the two bays having not yet appeared. Margaritifer, which could hardly be detected November 26, two days later was readily seen as a flattened angle. December 1 it presented its usual form, except that it was still rather short, about 350 miles, but rapidly increased in length. December 2 it measured 600 miles, and December 4, 750. The mean rate of growth was 4 miles an hour. The bay in Sabaeus grew at about the same rate, and both it and Margaritifer advanced towards the north. The former was much the darker of the two. November 28 Acidalium was of a dull grey color, but two days later it was distinctly bluish as compared to Sabaeus, which was nearly equally dark. The blue continued to increase in intensity, until December 4, when it was very striking. Judged by the experience of former years the blue will not last for more than a month or two, when it will be again replaced by grey, or a chocolate brown. Generally the dark areas are bluest nearest the ice. Polariscope tests made in 1892 and 1894 showed that the blue areas were the only ones on the planet reflecting polarized light. This we attributed at the time to a shiny surface reflecting the Martian atmosphere. It is expected that later both Sabaeus and the northern portion of the Syrtis Major will turn blue, but at present they are merely of a dull uniform grey color, quite different from Acidalium.

The first appearance of the third and fourth dark regions was rather sensational. A slight darkening was noted on the terminator November 17, which was seen again December 13, but was not visible two days later. The next night however, December 16, a sharply defined triangular bay of the shape and size of Margaritifer was conspicuously visible in longitude 185°. The following night to my surprise another bay exactly like it appeared, in longitude 160°. These two bays were about 700 miles in length, and half as wide at their northern ends. Their southern ends at first were pointed but later became more rounded, and a narrow strip of cloud crossed the following one December 19, dividing it in two parts. Later cloud veiled the whole of it for a few days making it appreciably fainter than its companion. Both exhibited a bluish tint at times.

Judged by the drawings made prior to December 16 and 17, it does not appear likely that these bays existed in their present form prior to these dates. The writer has written to certain European astronomers however, who, owing to their different longitude, should be able to

answer this question definitely. The bays occupied a position just north of Propontis, and it is thought that the shading has never before been observed in this particular and striking form.

The outline of the snow cap was not always circular but was at times indented in three different places, in longitudes 185°, 35°, and 260°, corresponding to the positions of three of the four dark bays. These indentations were usually noted when the cap was diminishing in size, the snow melting faster where the water was found. The first of them was first noted October 12 as a slight indentation, which was not very conspicuous. The second was clearly marked on October 30, but was not noticed when it next appeared November 26 and 28, but at the time of the great expansion of the Acidalium, November 30, it reappeared as a slight notch, by no means as marked as before. The northerly end of the notch had changed but little since the previous month, but the sides had melted away, the polar cap having receded 4° of latitude in the meantime, thus reducing the depth. The polar cap continued to recede on December 1, 2, 3, and 4, and the notch was entirely eliminated on the first two days, but reappeared deeply cut December 3, owing perhaps to a warm spell of weather. On December 4 it had again disappeared, but it was recorded, and painted, as an unusual feature, that on December 1, 2 and 4 the portion of the snow just north of water differed from the rest, being of a light blue color. That was the last we saw of it for several days; the notch had apparently filled up by freezing, and we were looking at the fresh ice at a very low angle, and not at snow. This is the most sharply marked change of temperature, if our explanation is correct, of which we have secured any evidence. A warm spell December 3, followed by a cold wave the next day. It is not to be expected that any relation should be found between Martian and terrestrial temperatures, but by a curious coincidence December 4 was the coldest night we have had for nearly two years, our minimum thermometer dropping to 57°.

The region was again seen December 10. The ice had melted, and the notch was now deeper than ever, in fact it nearly if not quite reached the limb, dividing the polar cap into two unequal parts, by a narrow channel about 100 miles in width. It was with interest that we waited until the gradual rotation of the planet should in a few days show us where the other end of the channel came out. We did not have to wait long. On December 15, on the side of the snow cap towards the terminator, a narrow black line appeared, one hundred miles in width, dividing the cap in two, and pointing directly across to where the other end had been last seen. On plotting the two observations in polar projection it was found that the channel was not quite straight, but curved around the pole towards longitude 120°, the two ends being

situated at 35° and 185°, or nearly on opposite sides of the pole. The channel practically followed the course of Lowell's canal Hypanis. This would seem to imply that the canal occupied a depressed area.

But a curious thing now happened: the next night the channel had entirely closed up, and extending south from the polar cap in the same longitude, 185°, we found the long triangular sea, already described as number 3. One might almost think that water had crossed the polar cap from the Acidalium Mare through this relatively narrow channel (its length was a trifle over 2000 miles,) and had come out and formed this new bay. The writer is not prepared to say that this is what really occurred, because the transportation of large quantities of water through a comparatively, if not absolutely, level channel, through such an enormous distance, presents almost insuperable difficulties, whether we attribute the ultimate source of energy to natural or artificial sources.

It is of no use however to keep on accumulating isolated facts without any explanation whatever. It seems to the writer that by far the best plan is to try and piece together what has been learned, according to some form of hypothesis. Whether this ultimately proves to be correct, or not, at all events our facts will be strung together according to some orderly system, where later they can be found when wanted.

We have already seen that under the warm spring sun the Martian polar cap melts so fast, that we can see the change occurring in the course of a few hours. We have also seen that, after an interval of six days, its boundary had retreated northwards a distance of some six hundred miles. Both of these facts indicate that the ice is thin. In our next report we hope to present in either tabular or graphical form a representation of our measures of the size of the ice cap. This will show that on several occasions for nearly a week at a time it has retreated northwards at a nearly uniform rate. This would imply that it is not mere hoarfrost, which would all melt at once, but a layer of snow of appreciable and gradually increasing thickness. That is we are dealing with actual snow storms on Mars.

Now as far as the water is concerned, let us take the largest body observed, the Acidalium Mare. On November 28 its meridional length was 500 miles; two days later it measured 1000. Its mean breadth was 700 miles, not including the narrow strip bordering the ice. At the same time that it increased in length, the polar cap was advancing, from latitude 61° on the 28th to 56° on the 30th, making the increase in length about 200 miles more. Neglecting this latter feature however for the moment, we find that we have a body of water measuring 500 by 700 miles deposited in some manner where two days before no water was visible. Admitting that it was water, which its shiny surface

and blue color can hardly leave open to question, it is reasonably certain that it could not have been very deep. The most plausible hypothesis would seem to be that we have here a marsh, whose great size confirms our views obtained from other sources, that the surface of Mars is extremely level as compared with that of either the earth or moon. Our largest terrestrial marsh lies along the Amazon valley for perhaps a thousand miles. During the rainy season an area several hundred miles in breadth is flooded to the depth of several feet.

This area on Mars is very dark, with a moderate amount of blue,—just enough to enable one to be sure of its existence when compared with the color of other portions of the planet. The appearance, it is thought, might be produced by a moist level plain full of little pools of water, reflecting the Martian sky. A slight depth of water only would therefore be required, which might be produced by an exceptionally heavy rainfall, occurring at night. The fact that the polar cap was increasing in size at the same time that the water appeared supports this explanation. So again we have evidence of heavy clouds and storms upon Mars, and not a mere deposition of frost or dew. Heavy snow and rainstorms almost necessarily imply an atmosphere of considerable density.

With regard to the canal crossing the polar cap, the simplest explanation of its closing up is that it froze over. The three other marshes it is thought were flooded in a similar manner. When we consider the vast amounts of water transported across the surface of our own planet by our ordinary cyclonic winter storms, it seems much easier to believe that something similar occurs upon Mars during the night time, when we know it to be much more cloudy than by day, than to believe that the distribution of its water supply is maintained by an enormous system of irrigation canals, the motive power for which is supplied either by natural or artificial means.

It is recorded that no green was visible upon the disk either November 1 or 7, although from previous observations it was expected to appear soon after the snow cap began to melt. But November 17 the whole of the southern *maria* appeared of a distinct greyish green tint, quite unlike the northern shaded regions, which were as dark, and in places nearly as wide. They were simply dull grey, but the green at the south was recorded as unmistakable. The equivalent terrestrial date was March 13. Since then portions of the southern *maria* have been constantly recorded as green or greenish, but no green has yet been observed north of the equator, which is rather surprising since it is from there that all the water comes.

In Lowell's brilliant paper on "The Cartouches of Mars" published in Bulletin No. 12 of his observatory, he states that the canals in successive latitudes develop one after another as the water reaches them from the melting of the polar caps, that after crossing the equator the water continues on towards the other pole, developing canals as it goes. He finds that the water requires 52 days to descend from latitude 72° to 0°, or at the rate of 2.1 miles per hour.

If we consider the appearance of the green color in the *maria* as the bursting forth of vegetation on the first receipt of water from the melting snows, we find that the first green in the southern hemisphere developed 15 days after the northern snow cap had reached its maximum size, and 14 days before the northern vernal equinox of the planet.

On November 7, 17, and 28 the southern portions of the southern *maria* were shown as distinctly darker than the northern portions,—a most unusual appearance, possibly due to thin cloud along the northern border. Immediately afterwards the northern border began to develop its characteristic detail and outlines, as previously described. This practically coincided with the northern vernal equinox.

Other material which would naturally appear in this Report will be deferred to the next, as the present paper is already longer than was originally intended. In computing the accompanying table of Data the writer has concluded to abandon the use of the Heliocentric Longitude of Mars, and instead to substitute the Planetocentric Longitude of the Sun ⊙, since the latter quantity is based on the same fundamental elements that are used in computing the remainder of the Physical Ephemeris of the planet. When Mars reaches ⊙ = 0°.0 the equivalent terrestrial date will be designated as March 20, and the Martian orbit will be divided into 365 equal angular divisions, the date increasing directly in proportion to ⊙.

Another change which experience has suggested is in the relocation of the six reference sections upon the planet's surface. It was at first proposed that each section should be 60° in width, the central meridian of the first section lying in longitude 0°. It was found however that with this arrangement all the more striking features of the planet would present themselves near the limb, and would therefore not be seen to advantage. To remedy this defect the central meridian of the first section has been changed to longitude 40°. The other central meridians are consequently 100°, 160°, 220°, 280°, and 340°. This causes all of the prominent features of the planet to be well seen. An endeavor will be made to have future drawings constructed with one or the other of these meridians nearly central.

TABLE OF DATA.

No.	1913	⊙ °	T. D.	Long. ▫	Lat. °	Sun °	Diam. ″	Seeing
12	Nov. 1	345.2	Mar. 5	306	+ 9	—6	10.5	8
13	7	348.3	8	242	+10	—5	10.9	9
14	17	353.3	13	187	"	—3	11.9	6
15	26	357.8	17	51	"	—1	12.7	4
16	28	358.8	18	55	"	"	12.9	4
17	30	359.8	19	0	"	0	13.1	8
18	Dec. 1	0.3	20	42	"	"	13.2	9
19	"	"	"	60	"	"	"	7
20	2	0.8	"	4	"	"	13.3	4
21	"	"	"	29	"	"	"	"
22	3	1.3	21	346	"	+1	13.4	8-7
23	"	"	"	27	"	"	"	6
24	4	1.8	"	40	+9	"	13.5	12-11
25	"	"	"	49	"	"	"	—
26	8	3.7	23	306	"	+2	13.9	4
27	10	4.7	24	273	"	"	14.0	8
28	"	"	"	352	"	"	"	10
29	"	"	"	1	"	"	"	8
30	12	5.7	25	252	"	"	14.2	8
31	13	6.2	26	221	+8	"	14.3	6
32	"	"	"	237	"	"	"	"
33	15	7.1	27	227	"	+3	14.4	10
34	16	7.6	"	192	"	"	14.5	8-6
35	"	"	"	224	"	"	"	—

It may be mentioned in this connection that the writer has opened correspondence with a number of observers in different longitudes around the world, and it is hoped by this means to be able to secure information about any particular detail upon Mars, after, owing to planetary rotation, it has turned so as to be no longer visible in the writer's own longitude. It is also hoped to be able to reciprocate in kind, and to furnish information to others desiring it about any formation that may have passed beyond the range of their vision. It is thought that the Table of Data published with these reports, besides being useful to those readers interested in studying the precise conditions on the planet, when any particular change was noted, with reference to use at future oppositions, will also be useful to others in other longitudes. By examining them they will be able to see exactly on what dates any formation in which they may be interested, was observed by the writer, and thus whether he can give them any desired information about it.

PARTIAL ECLIPSE OF THE MOON MARCH 11, 1914.

WILLIAM F. RIGGE.

The partial eclipse of the moon of March 11, 1914 will be completely visible all over the United States. The accompanying diagram will give the particulars.

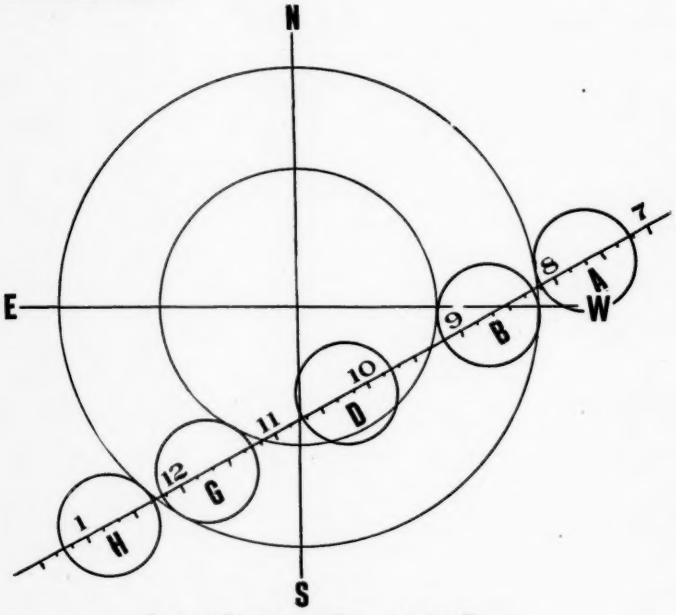


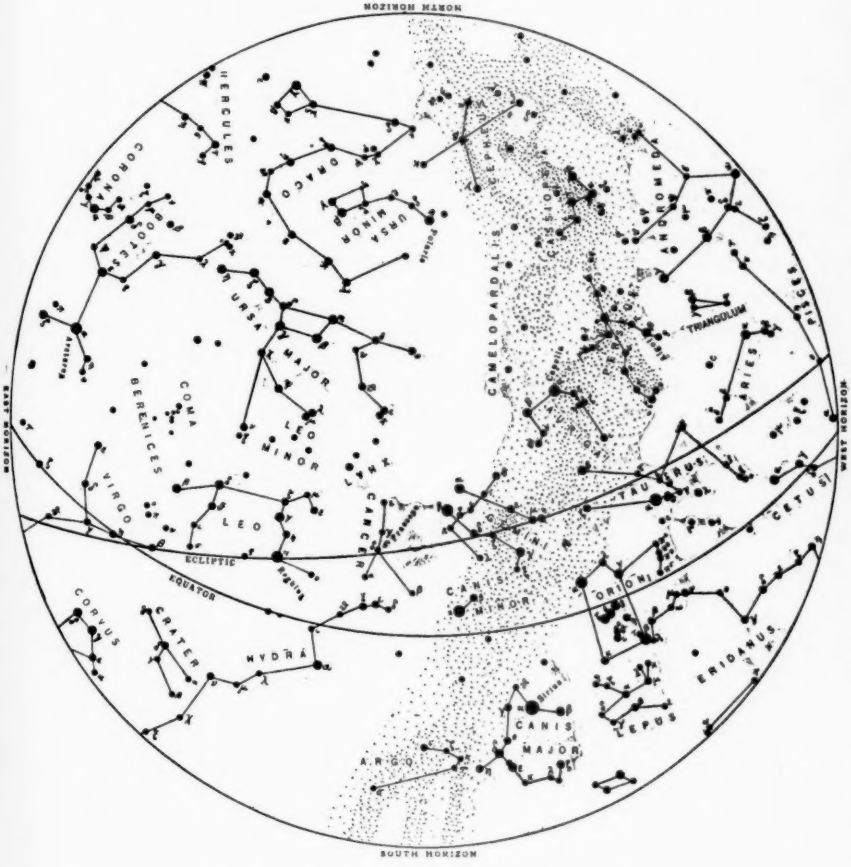
DIAGRAM SHOWING THE DETAILS OF THE ECLIPSE.

The largest circle is the earth's penumbra, and the next in size its shadow. The diagram must always be held in such a way, when comparing it with the moon in the sky, so that the line NS points to the north star. The oblique line is the moon's relative orbit, its positions being indicated for every ten minutes from 7:00 P.M. to 1:30 A.M., Central time. The five small circles represent the moon at important moments. When its center is at A, at 7:41 P. M., the moon enters penumbra. At B, at 8:42, the moon enters shadow. At D, at 10:13, we have the Middle of the Eclipse, when the moon has penetrated farthest into the earth's shadow, about 91 per cent of its diameter being then eclipsed. At G, at 11:44, the moon leaves shadow, and at H, at 12:45 A. M., the moon leaves penumbra.

Creighton University Observatory,
Omaha, Nebr.

PLANET NOTES FOR MARCH, 1914.

The sun will move from nearly eight degrees south to more than four degrees north of the equator during the month. It will cross the equator a little before noon (Greenwich Mean Time) on Saturday, March 21. At this time, the only time in the year, its right ascension and declination will both be zero.



THE CONSTELLATIONS AT 9:00 P. M. MARCH 1, 1914.

The phases of the moon for this month are as follows:

First Quarter	Mar. 5	at	5 A.M.	C. S. T.
Full Moon	12	"	4 A.M.	"
Last Quarter	18	"	8 P.M.	"
New Moon	26	"	6 P.M.	"

Mercury will be too near to the sun throughout most of the month to be visible. It will pass between the earth and the sun on March 10. Toward the end of the month it will be quite a distance west of the sun and may be visible on the eastern horizon just before sunrise.

Venus will move east more rapidly than the sun. It will also move northward faster than the sun, and by the end of the month will just be visible on the western horizon at sunset. Its phase during this month will be nearly full as it is just emerging from behind the sun and is consequently turning the illuminated surface toward us. It will not be at its maximum brightness because of its great distance from the earth.

Mars will be in very favorable position for observation. It will be moving slowly eastward and will be near the meridian each day at sunset. It will be moving away from the earth and at the middle of the month will be nearly 100,000,000 miles away.

Jupiter will again be coming out of the rays of the sun and will rise a little while before the sun. It is still rather far south. During this month it will be about as bright as Sirius.

Saturn will be in quadrature, 90 degrees east of the sun, on March 2. It will be moving eastward and will remain in good position throughout the month. It is twenty degrees north of the equator and will therefore cross the meridian very high in the sky at this latitude.

Uranus also will again reappear after having been hidden by the sun. It may be seen a few hours before sunrise in the southeast.

Neptune will have a slow retrograde motion, and will be in good position for observation. It will be found in the eastern part of the constellation Gemini.

Saturn's Satellites.

CENTRAL STANDARD TIME.

E = eastern elongation; W = western elongation;
I = inferior conjunction; S = superior conjunction.

II. Enceladus. Period $1^d\ 8^h.9$

		h			h			h			h
Mar.	1	15.3 E	Mar.	8	11.8 E	Mar.	15	8.2 E	Mar.	20	19.8 E
	3	0.2 E		9	20.7 E		16	17.1 E		22	6.7 E
	4	9.1 E		11	5.6 E		18	2.1 E		23	13.6 E
	5	18.0 E		12	14.5 E		19	10.9 E		24	22.5 E
	7	4.9 E		13	23.3 E						

III. Tethys. Period $1^d\ 21^h.3$

Mar.	1	6.2 E	Mar.	8	19.4 E	Mar.	16	8.7 E	Mar.	23	22.1 E
	3	3.5 E		10	16.8 E		18	6.1 E		25	19.4 E
	5	0.8 E		12	14.1 E		20	3.4 E		27	16.7 E
	6	22.1 E		14	11.4 E		22	0.7 E			

IV. Dione. Period $2^d\ 17^h.7$

Mar.	3	1.7 E	Mar.	11	8.9 E	Mar.	19	12.1 E	Mar.	24	23.5 E
	5	19.4 E		14	0.6 E		22	7.8 E		27	17.2 E
	8	13.1 E		16	18.3 E						

V. Rhea. Period $4^d\ 12^h.5$

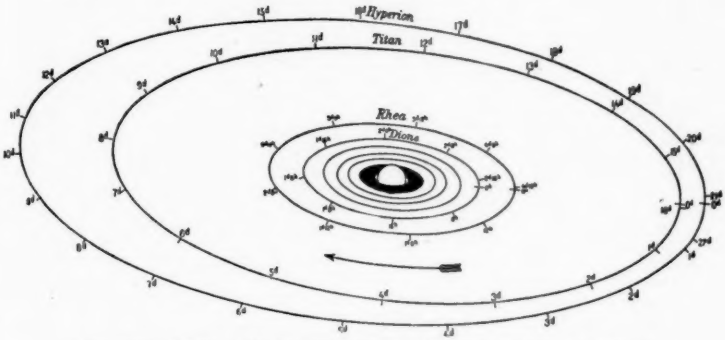
Mar.	1	1.9 E	Mar.	10	4.9 E	Mar.	14	15.4 E	Mar.	19	4.0 E
	5	14.4 E									

VI. Titan. Period $15^d\ 23^h.3$

h	h	h	h
Mar. 1 1.7 S	Mar. 5 4.8 E		

VII. Hyperion. Period $21^d\ 7^h.6$

Mar. 1.4 I	Mar. 13.3 S	Mar. 22.8 I	Mar. 28.7 W
7.3 W	18.1 E		



Apparent Orbits of the Seven Inner Satellites of Saturn, at date of Opposition, December 6, 1913, as seen in an Inverting Telescope.

VIII. Japetus. Period $79^d\ 22^h.1$

Mar. 5.2 E Mar. 26.1 I

IX. Phoebe. Period $580^d\ 2^h.9$

	α Ph.−α Sat.	δ Ph.−δ Sat.		α Ph.−α Sat.	δ Ph.−δ Sat.
	m s	′ ″		m s	′ ″
Mar. 2	+2 16.1	+6 18	Mar. 18	+2 21.8	+6 44
6	2 17.9	6 26	22	2 22.5	6 47
10	2 19.5	6 33	26	2 23.0	6 49
14	+2 20.8	+6 39	30	+2 23.2	+6 50

Occultations Visible at Washington.

Date 1914	Star's Name	Magnitude	IMMERSION. Washington M.T.	IMMERSION. Angle from N.	EMERSION. Washington M.T.	EMERSION. Angle from N.	Duration
			h m	°	h m	°	h m
Mar. 1	20 H^1 Arietis	6.4	7 48	61	8 57	259	1 9
3	18 Tauri	5.6	6 3	84	7 31	245	1 28
5	406 B. Tauri	5.6	13 27	109	14 18	268	0 51
6	49 Aurigae	5.1	5 17	77	6 38	286	1 22
8	γ Cancri	4.7	10 47	47	11 8	14	0 21
9	8 Leonis	5.9	8 11	100	9 22	321	1 11
11	83 Leonis	6.3	8 12	85	9 2	345	0 50
11	τ Leonis	5.2	8 51	77	9 35	357	0 44
14	43 H. Virginis	5.5	10 7	83	10 54	342	0 46
14	231 G. Virginis	6.4	10 59	110	12 1	317	1 2
14	236 G. Virginis	5.7	11 48	88	12 42	341	0 55
19	248 B. Sagittarii	5.7	16 47	40	17 49	304	1 2
29	μ Arietis	5.7	7 11	129	7 49	202	0 93

VARIABLE STARS.

Approximate Magnitudes of Variable Stars of Long Period on Jan. 1, 1914.

[Communicated by the Director of Harvard College Observatory, Cambridge, Mass.]

Name.	R. A. 1900.	Decl. 1900.	Magn.	Name.	R.A. 1900	Decl. 1900	Magn
	h m	° ′			h m	° ′	
S Sculptoris	0 10.3	−32 36	6.6	V Camelop.	5 49.4	+74 30	<13.0
X Androm.	10.8	+46 27	<13.0	Z Aurigae	53.6	+53 18	10.2
T Cassiop.	17.8	+55 14	7.8	V Monoc.	6 17.7	− 2 9	9.9 *i*
R Androm.	18.8	+38 1	11.0	RW Monoc.	29.3	+ 8 54	9.0
S Ceti	19.0	− 9 53	<10.0	U Lyncis	31.8	+59 57	14.2
Y Cephei	31.3	+79 48	13.0	S Lyncis	35.9	+58 0	<13.0
RW Androm.	41.9	+32 8	<13.0	X Gemin.	40.7	+30 23	13.4
V Androm	44.6	+35 6	11.2	Nova. Gem. No. 2	45.5	+32 17	11.0
RR Androm.	45.9	+33 50	9.3 *i*	Y Monoc.	51.3	+11 22	9.5 *i*
RV Cassiop.	47.1	+46 53	9.5*d*	X Monoc.	52.4	− 8 56	9.0
W Cassiop.	49.0	+58 1	10.3	V Can. Min.	7 1.5	+ 9 2	11.4*d*
Z Ceti	1 1.6	− 2 1	<13.0	R Gemin.	1.3	+22 52	9.9*d*
U Androm.	9.8	+40 11	10.8 *i*	R Can. Min.	3.2	+10 11	8.9
– Androm.	10.4	+41 12	12.8	RR Monoc.	12.4	+ 1 17	12.2
S Piscium	12.4	+ 8 24	12.4*d*	RY Gemin.	21.7	+15 52	8.6
S Cassiop.	12.3	+72 5	11.7*d*	S Can. Min.	27.3	+ 8 32	8.8 *i*
RZ Persei	23.6	+50 20	13.4	U Can.Min.	35.9	+ 8 37	9.0
R Piscium	25.5	+ 2 22	9.0	R Cancri	8 11.0	+12 2	11.6
RU Androm.	32.8	+38 10	12.0*d*	V Cancri	16.0	+17 36	8.2
Y Androm.	33.7	+38 50	9.3 *i*	T Lyncis	16.4	+33 51	10.0
X Cassiop.	49.8	+58 46	10.0	W Cancri	9 4.0	+25 39	12.2
U Persei	53.0	+54 20	9.5	Y Draconis	31.1	+78 18	13.8
R Arietis	2 10.4	+24 35	11.4	R Leonis	42.2	+11 54	7.4 *i*
W Androm.	11.2	+43 50	7.0	U Hydrae	10 32.6	−12 52	4.8
Z Cephei	12.8	+81 13	12.4*d*	R Urs. Maj.	37.6	+69 18	13.0
o Ceti	14.3	− 3 26	8.2	T Urs .Maj.	12 31.8	+60 2	12.6
S Persei	15.7	+58 8	10.0	RS Urs. Maj.	34.4	+59 2	11.4*d*
R Ceti	20.9	− 0 38	<10.0	S Urs. Maj.	39.6	+61 38	11.0*d*
RR Persei	21.7	+50 49	14. 3	R Hydrae	13 24.2	−22 46	7.4
U Ceti	28.9	−13 35	8.8*d*	S Virginis	27.8	− 6 41	6.6 *i*
RR Cephei	29.4	+80 42	9.3	T Urs. Min.	32.6	+73 56	8.8
R Trianguli	31.0	+33 50	7.2 *i*	R Can. Ven.	44.6	+40 2	10.4 *i*
W Persei	43.2	+56 34	9.1	U Urs. Min.	14 15.1	+67 15	9.0 *i*
U Arietis	3 5.5	+14 25	12.7 *i*	RS Virginis	22.3	+ 5 8	12.3
X Ceti	14.3	− 1 26	9.2 *i*	V Bootis	25.7	+39 18	10.3
Y Persei	20.9	+43 50	10.0*d*	R Camelop.	25.1	+84 17	9.8 *i*
R Persei	23.7	+35 20	8.6	R Bootis	32.8	+27 10	7.5 *i*
U Camelop.	33.2	+62 19	7.6	RU Librae	27.7	−14 59	12.8
RW Tauri	57.8	+27 51	8.0	S Urs. Min.	15 33.4	+78 58	10.4
V Eridani	59.8	−16 0	9.3	X Herculis	59.6	+47 31	6.5
R Tauri	4 22.8	+ 9 56	<10.0	W Cor. Bor.	16 11.8	+38 3	9.5
W Tauri	22.2	+15 49	8.6	R Urs. Min.	31.3	+72 28	9.5
S Tauri	23.7	+ 9 44	<10.0	V Draconis	17 56.3	+54 53	13.5
– Tauri	32.8	+ 8 9	11.6	T Herculis	18 5.3	+31 0	10.0*d*
X Camelop.	32.6	+74 56	10.6*d*	W Draconis	5.4	+65 56	11.0
R Orionis	53.6	+ 7 59	11.4	X Draconis	6.8	+66 8	13.4
V Orionis	5 0.8	+ 3 58	<10.0	W Lyrae	11.5	+36 38	8.6
R Aurigae	9.2	+53 28	8.6	SV Draconis	31.2	+49 18	10.0 *i*
S Aurigae	20.5	+34 4	10.0	RY Lyrae	41.2	+34 34	13.2
W Aurigae	20.1	+36 49	11.6	R Scuti	42.2	− 5 49	5.7
SU Tauri	43.2	+19 2	12.6	RW Lyrae	42.1	+43 32	<12.0
Z Tauri	46.7	+15 46	<12.0	Z Lyrae	56.0	+34 49	10.7
RU Tauri	46.9	+15 57	13.2	V Lyrae	19 5.2	+29 30	<13.0
U Orionis	49.9	+20 10	11.3*d*	S Lyrae	9.1	+25 50	9.6

Approximate Magnitudes of Variable Stars of Long Period on Jan. 1, 1914.—Continued.

Name.	R. A. 1900.	Decl. 1900.	Magn.	Name.	R.A. 1900.	Decl. 1900.	Magn
	h m	° ′			h m	° ′	
X Lyrae	19 9.0	+26 36	9.2	RZ Cygni	20 48.5	+46 59	<10.0
U Draconis	9.9	+67 7	13.2	RS Capric.	21 1.7	−16 49	8.4
TZ Cygni	13.4	+50 0	10.6	TW Cygni	1.8	+29 0	12.7*d*
U Lyrae	16.6	+37 42	9.0	X Cephei	3.6	+82 40	<13.0
R Cygni	34.1	+49 58	11.6	R Equulei	8.4	+12 23	<13.0
TT Cygni	37.1	+32 23	8.2	T Cephei	8.2	+68 5	7.9*d*
RT Cygni	40.8	+48 32	11.5*d*	W Cygni	32.2	+44 56	6.2
TU Cygni	43.3	+48 49	10.4 *i*	S Cephei	36.5	+78 10	10.0*d*
χ Cygni	46.7	+32 40	7.6*d*	RU Cygni	37.3	+53 52	8.4
S Cygni	20 3.4	+57 42	<10.0	Y Pegasi	22 6.8	+13 52	12.6*d*
SV Cygni	6.5	+47 35	9.0	RS Pegasi	7.4	+14 4	12.0*d*
S Aquilae	7.0	+15 19	9.6	R Pegasi	23 1.6	+10 0	9.4*d*
RS Cygni	9.8	+38 28	7.7	V Cassiop.	7.4	+59 8	8.3*d*
R Delphini	10.1	+ 8 47	9.4*d*	W Pegasi	14.8	+25 44	11.7
RT Capricorni	11.3	−21 38	7.6	S Pegasi	15.5	+ 8 22	10.9*d*
V Sagittae	15.8	+20 47	10.9 *i*	Z Cassiop.	39.7	+56 2	10.6*d*
U Cygni	16.5	+47 35	10.0*d*	R Cassiop.	53.3	+50 50	10.6*d*
RW Cygni	25.2	+39 39	8.4	Z Pegasi	55.0	+25 21	<11.0
SZ Cygni	29.6	+46 16	9.4	Y Cassiop.	58.2	+55 7	10.0 *i*
ST Cygni	29.9	+54 38	10.0	SV Androm.	59.2	+39 33	11.0*d*

The letter *i* denotes that the light is increasing; the letter *d*, that the light is decreasing; the sign < that the variable is fainter than the appended magnitude.

The above magnitudes have been compiled at the Harvard College Observatory from observations made by the following observers:—H. C. Bancroft, Jr., T. C. H. Bouton, N. Bruseth, A. B. Burbeck, A. P. C. Craig, Edward Gray, S. C. Hunter, S. H. Huntington, M. W. Jacobs, Jr., J. B. Lacchini, F. C. Leonard, C. Y. McAteer, O. Mach, W. T. Olcott, P. G. O'Reilly, E. Padova, E. W. Putnam, H. M. Swartz, D. Todd, H. W. Vrooman and I. E. Woods.

Maxima of Variable Stars of Short Period.

[Calculated by Julia M. Hawkes and May E. Abbott at Goodsell Observatory.]

Given to the nearest hour in Greenwich mean time. To obtain Eastern standard time subtract 5^h; Central standard time 6^h; etc.

Star	R. A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of maxima in 1914 March
	h m	° ′		d h	d h d h d h d h d h
SX Cassiop.	0 05.5	+54 20	8.6— 9.4	36 13.7	23 16
SY Cassiop.	0 09.8	+57 52	9.3— 9.9	4 1.7	6 22; 15 2; 23 5; 31 8
RR Ceti	1 27.0	+ 0 50	8.3— 9.0	0 13.3	2 16; 10 10; 18 4; 25 22
RW Cassiop.	1 30.7	+57 15	8.9—11.0	14 19.2	8 2; 22 22
V Arietis	2 09.6	+11 46	8.3— 9.0	0 23.8	2 12; 10 11; 18 10; 26 8
SU Cassiop.	2 43.0	+68 28	6.5— 7.0	1 22.8	7 3; 14 22; 22 17; 30 12
TU Persei	3 01.8	+52 49	11.4—12.2	0 14.6	3 15; 10 21; 18 5; 25 11
RW Camelop.	3 46.2	+58 21	8.2— 9.4	16 00.0	1 17
SX Persei	4 10.2	+41 27	10.4—11.2	4 07.0	4 12; 13 2; 21 16; 30 6
SV Persei	42.8	+42 07	8.8— 9.6	11 03.1	9 2; 20 5; 31 8
RX Aurigae	4 54.5	+39 49	7.2— 8.1	11 15.0	8 0; 19 15; 30 6
SX Aurigae	5 04.6	+42 02	8.0— 8.7	1 12.8	4 18; 12 10; 20 2; 27 18
SY Aurigae	05.5	+42 41	8.4— 9.5	10 03.3	3 8; 13 11; 23 14
Y Aurigae	21.5	+42 21	8.6— 9.6	3 20.6	6 3; 13 19; 21 12; 29 6
RZ Gemin.	5 56.6	+22 12	9.1—10.0	5 12.7	6 5; 11 18; 17 6; 28 8
RS Orionis	6 16.5	+14 44	8.2— 8.9	7 13.6	4 13; 12 3; 19 16; 27 6
T Monoc.	19.8	+ 7 08	5.7— 6.8	27 00.3	3 10; 30 10

Maxima of Variable Stars of Short Period.—Continued.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of maxima in 1914. March
	h m	° ′		d h	d h d h d h d h d h
RZ Camelop.	23.7	+67 06	11.0—13.0	0 11.5	3 12; 10 17; 17 22; 25 3
W Gemin.	6 29.2	+15 24	6.7— 7.5	7 22.0	8 19; 16 16; 24 14
ζ Gemin.	6 58.2	+20 43	3.7— 4.3	10 03.7	3 8; 13 12; 23 16
RU Camelop.	7 10.9	+69 51	8.5— 9.8	22 06.5	11 8
RR Gemin.	7 15.2	+31 04	10.0—11.5	0 09.5	8 5; 16 3; 24 2
V Carinae	8 26.7	−59 47	7.4— 8.1	6 16.7	3 10; 10 2; 23 12; 30 4
T Velorum	8 34.4	−47 01	7.6— 8.5	4 15.3	8 3; 17 10; 26 16
V Velorum	9 19.2	−55 32	7.5— 8.2	4 08.9	4 19; 13 12; 22 6; 31 0
RR Leonis	10 02.1	+24 29	9.1—10.1	0 10.9	7 0; 13 19; 20 13; 27 8
SU Draconis	11 32.2	+67 53	8.9— 9.6	0 15.8	7 1; 13 15; 20 6; 26 20
S Muscae	12 07.4	−69 36	6.4— 7.3	9 15.8	3 16; 13 8; 23 0
SW Draconis	12.8	+70 04	8.8— 9.6	0 13.7	8 2; 16 1; 24 1
T Crucis	15.9	−61 44	6.8— 7.6	6 17.6	6 16; 13 9; 20 3; 26 20
R Crucis	18.1	−61 04	6.8— 7.9	5 19.8	2 1; 13 16; 25 8; 31 4
S Crucis	12 48.4	−57 53	6.5— 7.6	4 16.6	3 4; 12 13; 21 23; 31 8
W Virginis	13 20.9	− 2 52	8.7—10.4	17 06.5	11 21; 29 4
SS Hydrae	25.0	−23 08	7.4— 8.1	8 4.8	7 14; 15 19; 24 0
RV Urs. Maj.	13 29.4	+54 31	9.2— 9.9	0 11.2	7 9; 14 10; 21 10; 28 11
ST Virginis	14 22.5	− 0 27	10.3—11.4	0 09.9	3 19; 12 0; 20 6; 28 10
V Centauri	25.4	−56 27	6.4— 7.8	5 11.9	3 8; 14 7; 25 7; 30 19
RS Bootis	29.3	+32 11	8.9—10.0	0 09.1	5 21; 13 10; 20 23; 28 12
RU Bootis	14 41.5	+23 44	12.8—14.3	0 11.9	1 9; 8 19; 23 15; 31 1
R Triang. Austr.	15 10.8	−66 08	6.7— 7.4	3 09.3	1 19; 8 14; 22 3; 28 22
S Triang. Austr.	15 52.2	−63 29	6.4— 7.4	6 07.8	3 17; 10 1; 22 16; 29 0
S Normae	16 10.6	−57 39	6.6— 7.6	9 18.1	6 7; 16 1; 25 19
RW Draconis	33.7	+58 03	9.6—10.8	0 10.6	5 19; 14 16; 23 12
RV Scorpii	16 51.8	−33 27	6.7— 7.4	6 01.5	5 2; 11 4; 23 7; 29 8
X Sagittarii	17 41.3	−27 48	4.4— 5.0	7 00.3	2 16; 9 16; 23 17; 30 17
Y Ophiuchi	47.3	− 6 07	6.1— 6.5	17 02.9	7 9; 24 12
W Sagittarii	17 58.6	−29 35	4.3— 5.1	7 14.3	3 12; 11 3; 18 17; 26 7
Y Sagittarii	18 15.5	−18 54	5.4— 6.2	5 18.6	5 17; 11 12; 23 1; 28 20
U Sagittarii	26.0	−19 12	6.5— 7.3	6 17.9	4 0; 10 17; 24 5; 30 23
Y Scuti	32.6	− 8 27	8.7— 9.2	10 08.3	5 9; 15 18; 26 2
Y Lyrae	34.2	+43 52	11.3—12.3	0 12.1	2 0; 14 2; 20 2; 26 3
RZ Lyrae	39.9	+32 42	9.9—11.2	0 12.3	6 19; 12 22; 25 5; 31 8
RT Scuti	44.1	−10 30	9.1— 9.7	0 11.9	5 9; 11 8; 23 5; 29 4
κ Pavonis	18 46.6	−67 22	3.8— 5.2	9 02.2	1 10; 10 12; 19 14; 28 16
U Aquilae	19 24.0	− 7 15	6.2— 6.9	7 00.6	1 10; 8 10; 22 11; 29 12
XZ Cygni	30.4	+56 10	8.6— 9.3	0 11.2	4 11; 11 11; 18 10; 25 10
U Vulpec.	32.2	+20 07	6.5— 7.6	7 23.5	1 7; 9 6; 17 6; 25 5
SU Cygni	40.8	+29 01	6.2— 7.0	3 20.3	2 7; 10 0; 17 16; 25 9
η Aquilae	47.4	+ 0 45	3.7— 4.5	7 04.2	3 4; 10 8; 24 16; 31 20
S Sagittae	51.5	+16 22	5.6— 6.4	8 09.2	8 4; 16 13; 24 22
X Vulpec.	19 53.3	+26 17	9.5—10.5	6 07.7	1 21; 8 5; 20 20; 27 4
X Cygni	20 39.5	+35 14	6.0— 7.0	16 09.3	10 4; 26 13
T Vulpec.	47.2	+27 52	5.5— 6.1	4 10.5	5 4; 14 0; 22 21; 31 18
WY Cygni	52.3	+30 03	9.6—10.4	0 13.5	1 4; 7 22; 21 9; 28 2
RV Capric.	55.9	−15 37	9.2—10.1	0 10.7	2 2; 8 19; 22 5; 28 23
TX Cygni	20 56.4	+42 12	8.5— 9.7	14 17.4	2 7; 17 0; 31 18
VY Cygni	21 00.4	+39 34	8.8— 9.5	7 20.6	6 10; 14 6; 22 3; 30 0
SW Aquarii	10.2	− 0 20	9.9—10.8	0 11.0	4 4; 11 2; 24 20; 31 18
VZ Cygni	21 47.7	+42 40	8.2— 9.2	4 20.7	2 0; 11 18; 21 15; 31 5
Y Lacertae	22 05.2	+50 33	9.1— 9.6	4 07.8	1 17; 10 8; 19 0; 27 16
δ Cephei	25.5	+57 54	3.7— 4.6	5 08.8	4 20; 15 14; 26 8; 31 16
Z Lacertae	36.9	+56 18	8.2— 9.0	10 21.1	2 12; 13 9; 24 6
RR Lacertae	37.5	+55 55	8.5— 9.2	6 10.1	6 23; 13 9; 19 19; 26 5
V Lacertae	22 44.5	+55 48	8.2— 8.9	4 23.6	2 12; 7 12; 17 11; 27 10
SW Cassiop.	23 03.7	+58 11	9.2— 9.7	5 10.6	5 9; 10 19; 21 16; 27 3
RS Cassiop.	32.6	+61 52	9.0—11.0	6 07.1	5 14; 11 22; 24 12; 30 19
RY Cassiop.	47.2	+58 11	9.3—11.8	12 03.4	3 83; 16 3; 28 6
V Cephei	23 51.7	+82 38	6.0— 7.0	0 23.9	1 10; 11 10; 21 9; 31 8

Minima of Variable Stars of Short Period.

[Calculated by May E. Abbott, at Goodsell Observatory.]

Given to the nearest hour in Greenwich mean time; to obtain eastern Standard time subtract 5h; Central Standard 6h; etc.

Star	R. A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of minima in 1914 March							
	h m	° ′		d h	d	h	d	h	d	h	d	h
SY Androm.	0 08.0	+43 09	9.5—13.0	34 21.8			13	2				
RT Sculptor.	31.5	−26 13	9.6—10.5	0 12.3	5	13;	13	5;	20	21;	28	14
UU Androm.	38.5	+30 24	10.7—11.9	1 11.7	6	19;	14	6;	21	15;	29	2
U Cephei	0 53.4	+81 20	7.0— 9.0	2 11.8	5	15;	13	4;	20	15;	28	2
Z Persei	2 33.7	+41 46	9.4—12	3 01.4	5	1;	11	4;	23	9;	29	12
TW Cassiop.	37.6	+65 19	8.2— 9.0	1 10.3	5	21:	13	0;	20	4;	27	7
RY Persei	39.0	+47 43	8.0—10.3	6 20.7	1	10;	8	7;	22	0;	28	21
RZ Cassiop.	39.9	+69 13	6.9— 8.1	1 04.7	5	18;	12	22;	20	2;	27	6
TX Cassiop.	44.4	+62 22	9.4—10.1	2 22.2	2	3;	10	22;	19	17;	28	11
ST Persei	2 53.7	+38 47	8.5—10.5	2 15.6	3	19;	11	18;	19	16;	27	15
RX Cassiop.	2 58.8	+67 11	8.6— 9.1	32 07.6			1	8				
Algol	3 01.7	+40 34	2.3— 3.5	2 20.8	2	4;	13	15;	25	2;	30	20
RT Persei	16.7	+46 12	9.5—11.5	0 20.4	1	8;	8	3;	21	17;	28	12
λ Tauri	55.1	+12 12	3.3— 4.2	3 22.9	2	9;	10	7;	18	4;	26	2
RW Tauri	3 57.8	+27 51	7.1—<11	2 18.5	7	22;	16	5;	24	12		
RV Persei	4 04.2	+33 59	9.5—11.0	1 23.4	8	11;	16	8;	24	6		
RW Persei	13.3	+42 04	8.8—11.0	13 04.8			10	21;	24	2		
SZ Tauri	31.4	+18 20	7.2— 7.7	3 03.6	8	17;	18	4;	27	15		
RS Cephei	4 48.6	+80 06	9.5—12.0	12 10.1	3	19;	16	5;	28	15		
TT Aurigae	5 02.8	+39 27	7.8— 8.7	0 16.0	6	17;	13	9;	20	1;	26	17
RY Aurigae	11.5	+38 13	10.7—11.7	2 17.5	3	13;	14	1;	24	23;	30	10
RZ Aurigae	42.9	+31 40	10.6—13.3	3 00.3	4	0;	10	0;	22	1;	28	2
SV Tauri	45.8	+28 05	9.4—11.0	2 04.0	8	4;	16	20;	25	12		
Z Orionis	50.2	+13 40	9.7—10.7	5 04.9	8	20;	19	6;	25	16		
SV Gemin.	54.6	+24 28	9.8—<11	4 00.2	1	3;	9	4;	17	4;	25	4
RW Gemin.	5 55.4	+23 08	9.5—11.0	2 20.8	4	18;	10	12;	21	23;	27	17
U Columbae	6 11.2	−33 03	9.2—10.0	2 19.2	6	5;	11	19;	23	0;	28	15
SX Gemin.	22.0	+20 37	10.8—11.5	1 08.8	1	4;	9	8;	17	13;	25	18
RW Monoc.	29.3	+ 8 54	9.0—10.8	1 21.7	4	16;	12	7;	19	22;	27	13
RX Gemin.	43.6	+33 21	8.8— 9.6	12 05.0			12	3;	24	8		
RU Monoc.	6 49.4	− 7 28	9.8—10.5	0 21.5	4	9;	11	13;	18	17;	25	21
R Can. Maj.	7 14.9	−16 12	5.8— 6.4	1 03.3	9	18;	18	20;	27	22		
RY Gemin.	21.7	+15 52	8.9—<10	9 07.2	8	23;	18	6;	27	13		
Y Camelop.	27.6	+76 17	9.5—12	3 07.3	1	17;	11	15;	21	13;	31	11
TX Gemin.	30.3	+17 8	10.0—11.9	2 19.2	9	5;	17	15;	26	0		
RR Puppis	43.5	−41 08	9.4—10.7	6 10.3	6	3;	12	13;	25	10;	31	20
V Puppis	7 55.4	−48 58	4.1— 4.8	1 10.9	7	3;	14	10;	21	17;	28	23
X Carinae	8 29.1	−58 53	7.9— 8.7	0 13.0	1	10;	9	13;	17	16;	25	18
S Cancri	8 38.2	+19 24	8.2—10	9 11.6	5	10;	14	22;	24	10		
RX Hydrae	9 0.8	− 7 52	9.1—10.5	2 6.8	6	6;	15	9;	24	12		
S Antliae	27.9	−28 11	6.3— 6.8	0 07.8	2	7;	8	19;	21	18;	28	6
S Velorum	29.4	−44 46	7.8— 9.3	5 22.4	3	6;	9	4;	21	1;	26	23
Y Leonis	9 31.1	+26 41	9.3—11.2	1 16.5	3	23;	12	9;	20	19;	29	6
RR Velorum	10 17.8	−41 36	10.0—10.9	1 20.5	3	3;	12	10;	21	16;	30	23
SS Carinae	10 54.2	−61 23	12.2—12.8	3 07.2	2	6;	8	21;	22	2;	28	16
ST Urs. Maj.	11 22.4	+45 44	6.7— 7.2	8 19.2	8	5;	17	0;	25	19		
RW Urs. Maj.	35.4	+52 34	10.3—11.4	7 07.9	4	13;	11	21;	19	5;	26	13
Z Draconis	11 39.8	+72 49	9.9—13.6	1 08.6	2	0;	8	19;	22	9;	29	4
RZ Centauri	12 55.6	−64 05	8.5— 8.9	1 21.0	1	22;	9	10;	24	10;	31	22
SS Centauri	13 07.2	−63 37	8.8—10.4	2 11.5	8	6;	15	16;	23	3;	30	13
δ Librae	14 55.6	− 8 07	4.8— 6.2	2 07.9	7	4;	14	3;	21	3;	28	2
U Coronae	15 14.1	+32 01	7.6— 8.7	3 10.9	1	7;	8	5;	22	0;	28	22
TW Draconis	32.4	+64 14	7.3— 8.9	2 19.4	2	16;	11	2;	19	12;	27	22
SS Librae	15 43.4	−15 14	9.3—11.5	0 18.4	6	1;	13	16;	21	8;	29	0

Minima of Variable Stars of Short Period.—Continued.

Star	R. A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean time of minima in 1914 March							
	h m	° ′		d h	d h	d h	d h	d h				
SW Ophiuchi	16 11.1	— 6 44	9.2—10.0	2 10.7	4 8;	11 16;	19 0;	26 8				
SX Ophiuchi	16 12.6	— 6 25	10.5—11.2	2 01.5	2 10;	11 16;	18 22;	27 4				
R Arae	31.1	—56 48	6.8— 7.9	4 10.2	1 20;	10 16;	19 13;	28 9				
TT Herculis	16 49.9	+17 00	8.9— 9.3	20 18.1	6 5;	15 21;	26 23					
TU Herculis	17 09.8	+30 50	9.5—12	2 06.4	4 6;	11 0;	24 16;	31 11				
U Ophiuchi	11.5	+ 1 19	6.0— 6.7	0 20.1	8 13;	16 22;	25 8					
u Herculis	13.6	+33 12	4.6— 5.4	2 01.2	3 10;	9 14;	21 21;	28 1				
TX Herculis	15.4	+42 00	8.3— 9.0	1 00.7	8 5;	15 10;	22 15;	29 20				
RV Ophiuchi	29.8	+ 7 19	9. —12	3 16.5	4 2;	11 11;	18 20;	26 5				
SZ Herculis	36.0	+33 01	9.5—10.3	0 19.6	4 20;	12 25;	21 5;	29 9				
TX Scorpii	48.6	—34 13	7.5— 8.2	0 22.6	6 3;	13 16;	21 5;	28 18				
UX Herculis	49.7	+16 57	8.8—10.5	1 13.2	3 13;	11 6;	19 0;	26 18				
Z Herculis	53.6	+15 09	7.1— 7.9	3 23.8	5 11;	13 11;	21 10;	29 10				
WX Sagittae	53.6	—17 24	9.2—10.8	2 03.1	2 15;	11 4;	19 16;	28 5				
WY Sagittae	17 54.9	—23 1	9.5—10.6	4 16.0	8 7;	17 15;	26 23					
SX Draconis	18 03.0	+58 23	9.3—10.5	5 04.1	11 4;	21 12;	31 20					
RS Sagittarii	11.0	—34 08	5.9— 6.3	2 10.0	5 13;	12 19;	20 0;	27 6				
V Serpentis	11.1	—15 34	9.5—11.1	3 10.9	5 8;	12 6;	19 4;	26 2				
RZ Scuti	21.1	— 9 15	7.4— 8.3	15 03.2		7 7;	22 10					
RZ Draconis	21.8	+58 50	9.5—10.2	0 13.2	2 15;	10 21;	19 4;	27 10				
RX Herculis	26.0	+12 32	7.0— 7.6	0 21.3	3 17;	12 15;	21 12;	30 10				
SX Sagittarii	39.7	—30 36	8.7— 9.8	2 01.8	7 18;	16 2;	24 9					
RR Draconis	40.8	+62 34	9.3—13	2 19.9	2 16;	11 3;	19 15;	28 3				
RS Scuti	43.7	—10 21	9.3—10.3	0 15.9	2 5;	8 21;	22 4;	28 19				
β Lyrae	46.4	+33 15	3.4— 4.1	12 21.8		6 15;	19 12					
U Scuti	18 48.9	—12 44	9.1— 9.6	0 22.9	5 7;	14 21;	24 10					
RX Draconis	19 01.1	+58 35	9.3—10.2	1 21.4	8 4;	15 18;	23 8;	30 22				
RV Lyrae	12.5	+32 15	11. —12.8	3 14.4	8 3;	15 8;	22 13;	29 18				
RS Vulpec.	13.4	+22 16	6.9— 8.0	4 11.4	2 11;	11 10;	20 9;	29 8				
U Sagittae	14.4	+19 26	6.5— 9.0	3 09.1	4 15;	11 9;	24 22;	31 16				
Z Vulpec.	17.5	+25 23	7.3— 8.5	2 10.9	3 6;	10 15;	17 23;	25 8				
TT Lyrae	24.3	+41 30	9.3—11.6	5 05.8	2 13;	13 0;	23 12;	28 18				
UZ Draconis	26.1	+68 44	9.0— 9.8	1 15.1	3 16;	10 4;	23 5;	29 18				
SY Cygni	19 42.7	+32 28	10 —12	6 00.2	2 15;	8 15;	20 15;	26 15				
WW Cygni	20 00.6	+41 18	9.3—13.4	3 07.6	7 12;	14 3;	20 18;	27 9				
SW Cygni	03.8	+46 01	9. —11.7	4 13.8	9 9;	18 13;	27 16					
VW Cygni	11.4	+34 12	9.8—11.8	8 10.3	9 7;	17 17;	26 3					
RW Capric.	12.2	—17 59	8.8—10.6	3 09.4	1 5;	8 0;	21 13;	28 8				
UW Cygni	19.6	+42 55	10.5—13	3 10.8	5 10;	12 7;	19 5;	26 3				
W Delphini	33.1	+17 56	9.4—12.1	4 19.4	10 5;	19 19;	29 10					
RR Delphini	38.9	+13 35	10.5—11.8	4 14.4	5 21;	15 2;	24 7					
Y Cygni	48.1	+34 17	7.1— 7.9	1 12.0	5 14;	13 2;	20 14;	28 1				
WZ Cygni	49.3	+38 27	9.9—10.8	0 14.0	4 17;	10 14;	22 6;	28 2				
RR Vulpec.	20 50.5	+27 32	9.6—11.0	5 01.2	4 9;	14 12;	24 14					
VV Cygni	21 02.3	+45 23	12.1—13.8	1 11.4	3 3;	10 13;	17 22;	25 7				
AE Cygni	09.0	+30 20	10.8—11.4	0 23.3	9 11;	19 4;	28 21					
RY Aquarii	14.8	—11 14	8.8—10.4	1 23.2	4 19;	12 16;	20 12;	28 9				
UZ Cygni	55.2	+43 52	8.9—11.6	31 07.3		28 5						
RT Lacertae	21 57.4	+43 24	9.1—10.5	5 01.7	3 13;	13 16;	23 20					
RW Lacertae	22 40.6	+49 08	10.2—11.2	5 04.4	5 7;	15 16;	26 1;	31 5				
X Lacertae	22 45.0	+55 54	8.2— 8.6	5 10.6	1 21;	12 18;	23 15;	29 2				
TT Androm.	23 08.7	+45 36	11.3—12.6	2 18.3	1 13;	9 20;	18 3;	26 10				
Y Piscium	29.3	+ 7 22	9.0—12.0	3 18.4	4 22;	12 11;	20 0;	27 12				
TW Androm.	23 58.2	+32 17	8.6—11.5	4 02.9	3 15;	11 21;	20 3;	28 9				

New Variable Stars.—In *A. N.* 4697 three new variables are announced. The first of these, 26.1913 Cassiopeiae, in the position for 1900, $\alpha = 22^h\ 58^m.1$, $\delta = +\ 56°\ 6'.3$, was discovered photographically by C. R. D'Esterre. For a long time, nearly a year and a half during which observations were made, this star remained practically constant in brightness at about twelfth magnitude. Since May 6, 1913, it has become much fainter; the last observation given fixes it as being about of the sixteenth magnitude on August 25. It is suggested in the notice that the long period of relative brightness and rapid decline may indicate that it is a Nova rather far advanced.

Two other new variables,

27.1913 Aurigae, $\alpha = 7^h\ 21^m\ 35^s$, $\delta = +\ 41°\ 10'.4$ (1900)
28.1913 Lacertae, $\alpha = 22\ 38\ 53$, $\delta = +\ 42\ 59.2$ (1900)

are announced by R. Furuhjelm, Helsingfors. The former of these seems to vary through nearly three magnitudes, with the mean magnitude in the neighborhood of 10. The observations are as yet insufficient to determine its period. The second of these varies approximately from magnitude 10.3 to magnitude 13.4. Its period apparently is long.

In *A. N.* 4702, the star BD + 76° 784 ($8^m.8$) is announced by *A. Brun* as variable. It is designated 29.1913 Cephei, and has the position $\alpha = 20^h\ 13^m.0$, $\delta = +\ 76°\ 52'$ (1900). The variation was discovered by comparing plates taken at Greenwich in July and August 1899 with plates taken at the Harvard College Observatory in January 1902. This star has a range of about three magnitudes.

COMET AND ASTEROID NOTES.

Elements and Ephemeris of Giacobini's Comet 1900 III, 1913 *e*.—In *A. N.* 4700 Professor M. Ebell gives elliptic elements of comet 1913 *e*, from observations on the dates October 23, November 3 and 18, which show that the comet is identical with Giacobini's periodic comet 1900 III.

ELEMENTS OF COMET 1913 *e*.

Epoch 1913 Nov. 18.5 Berlin M. T.
$M = 2°\ 28'\ 53''.0$
$\omega = 171\ 29\ 39\ .9$
$\Omega = 195\ 52\ 24\ .4$ } 1913.0
$i = 30\ 43\ 36\ .2$
$\phi = 46\ 03\ 47\ .5$
$\mu = 544''.99375$
$\log a = 0.542410$
$T = 1913$ Nov. 2.10906 Ber. M. T.
Period = 6.5105 years

ELEMENTS OF COMET 1900 III.

by Abold and Scharbe
$T = 1900$ Nov. 28.0679 Berlin M.T.
$\omega = 171°\ 06'\ 19''.3$
$\Omega = 196\ 43\ 05\ .1$
$i = 29\ 50\ 54\ .6$
$\phi = 47\ 08\ 54\ .0$
$\log a = 0.543026$

The ephemeris for the last few dates given is as follows:

1914	True α h m s	True δ ° ′	log r	log Δ	Mag.
Jan. 25	3 19 30	−25 14.9	0.1816	0.0470	12.3
27	24 55	24 30.5			
29	30 12	23 46.6			
31	35 23	23 03.8			
Feb. 2	3 40 28	−22 21.8	0.2028	0.0870	12.7

Comet 1913 *f* Delavan.—The new comet has moved very slowly northwestward across the west boundary of the constellation *Eridanus* and is now describing a curve in *Cetus*. During February the motion will be almost northward and at the end of the month the comet will be not far from γ *Ceti*. The approximate course from the date of discovery to March 3 is shown upon the accompanying diagram, Fig. 1. The comet is faint in a small telescope, but is quite bright as seen with the 16-inch telescope of Goodsell Observatory. It has at all times a

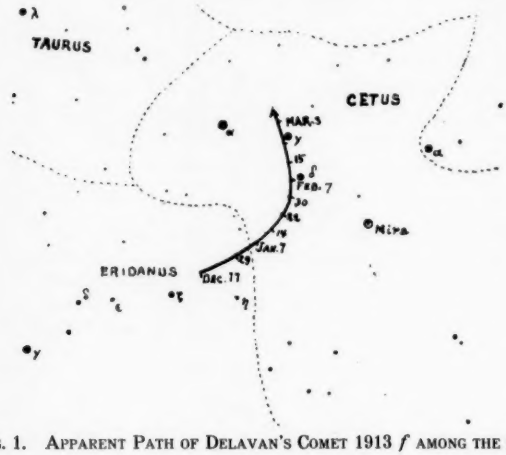


FIG. 1. APPARENT PATH OF DELAVAN'S COMET 1913 *f* AMONG THE STARS

strong central condensation and at times a sharply defined nucleus of about magnitude 11. The position could be quite accurately measured even in full moonlight.

The following observations of position are at hand:

Greenwich M.T.	Apparent α h m s	Apparent δ ° ′ ″	Observer	Place
1913 Dec. 17.6018	3 03 19.2	−7 25 24	Hussey	LaPlata
18.3085	02 41.1	−7 21 29	Graff	
18.5723	02 26.9	−7 19 57	Burton	Washington
18.6811	02 20.4	−7 19 14	Glancy	Cordoba
19.5133	01 37.2	−7 14 31	Burton	Washington
19.7153	01 26.1	−7 13 14	Glancy	Cordoba
20.5968	3 00 40.1	−7 08 11	Wilson	Northfield
22.5622	2 59 00.7	−6 57 00	Wilson	Northfield
23.5539	58 10.8	−6 49 41	Wilson	Northfield
29.5716	53 31.6	−6 08 52	Wilson	Northfield
1914 Jan. 7.5574	47 39.6	−4 59 19	Wilson	Northfield
13.5519	44 33.5	−4 08 37	Wilson	Northfield
14.5632	44 06.0	−3 59 43	Wilson	Northfield
21.5572	2 41 27.0	−2 55 54	Wilson	Northfield

The determination of the orbit appears to present unusual difficulties, the preliminary elements being extremely uncertain, as evidenced by the wide disagreement of those which have come to hand.

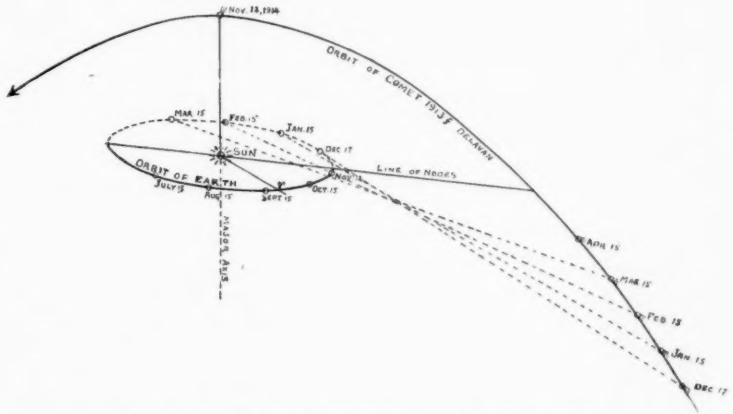
PRELIMINARY ELEMENTS OF COMET 1913 *f*.

Computers	Kobold	Einarsson and Nicholson	Wilson
Dates of Observation	Dec. 17, 18, 19	Dec. 17, 18 19	Dec. 17, 29. Jan. 14
T	1914 March 2.3211	1914 June 28.50	1914 Nov. 12.060
	Berlin M. T.	G. M. T.	G. M. T.
	° ′	° ′	° ′ ″
ω	7 40.1	172 20	95 22 40
Ω	126 32.6	65 17	57 18 24
i	13 04.6	58 26	72 10 53
log q	0.04526	0.050	0.086322

Even the last set of elements, by Wilson, depending upon observations nearly a month apart is, very uncertain, the representation of the middle place being

$$\left.\begin{aligned} \Delta\lambda \cos\beta &= -36''.4 \\ \Delta\beta &= -25\ .9 \end{aligned}\right\} \text{O—C.}$$

These residuals possibly may be reduced by variation of the distances but we have not time to do this before the Feburary number of POPULAR ASTRONOMY goes to press.



FIG, 2. DIAGRAM OF THE ORBIT OF DELAVAN'S COMET 1913 *f*.

The diagram, Fig. 2., prepared from the elements by Wilson, shows the relation of the comet's orbit to that of the earth. The comet is seen to be now at a great distance from the sun, nearly as far as Jupiter's orbit in December, and to be coming in toward perihelion. If these elements are anywhere near right the comet will be nearest the sun in November, but will at no time be nearer the earth than the sun is. It may be a hundred or more times as bright as it is now and so may become a rather conspicuous object, but it is hardly safe to make such predictions yet. During the spring and early summer the comet will be behind the sun.

EPHEMERIS OF COMET 1913 *f* DELAVAN

[Calculated from the elements by Wilson.]

1914 G.M.T.	True α	True δ	log *r*	log Δ	Brightness
	h m s	° ′ ″			
Feb. 3.5	2 38 42	−0 51 26	0.5878	0.5874	1.12
5.5	2 38 33	−0 31 29			
7.5	2 38 28	−0 11 12	0.5832	0.5901	1.13
9.5	2 38 27	+0 9 9			
11.5	2 38 30	+0 29 37	0.5785	0.5927	1.14
13.5	2 38 37	+0 50 15			
15.5	2 38 48	+1 11 01	0.5737	0.5951	1.16
17.5	2 39 2	+1 31 54			
19.5	2 39 20	+1 52 55	0.5689	0.5976	1.17
21.5	2 39 42	+2 14 4			
23.5	2 40 8	+2 35 20	0.5640	0.5998	1.18
25.5	2 40 37	+2 56 42			
27.5	2 41 9	+3 18 10	0.5590	0.6018	1.20
Mar. 1.5	2 41 44	+3 39 44			
3.5	2 42 23	+4 1 25	0.5540	0.6036	1.22

An observation of position obtained January 21 shows that the ephemeris is quite close and will enable our readers to follow the comet through February.

Elements of the Westphal-Delavan Comet 1913 *d*.—Mr. F. E. Seagrave has computed the following elements of the comet which was discovered by Delavan in September, using observations by Hussey on the dates September 26, 30 and October 4. These elements resemble those of Westphal's comet 1852 IV except in the inclination, which differs by nearly sixteen degrees.

$T = 1913$ Nov. 25.92 Gr. M. T.
$\omega = 55° 07' 58''$
$\Omega = 348\ 04\ 33$
$i = 24\ 16\ 24$
$\log a = 0.18722$
$\log q = 0.09615$
$\mu = 58''.772$

Elliptic Elements of Comet 1911 V (Brooks).—In *A. N.* 4701 Mr. E. E. Kühne, of Konigsberg, gives the following elliptic elements of the comet 1911 V, discovered by Brooks. The elements are based upon eight normal places of the comet, derived from observations extending over a period of 220 days and a heliocentric arc of 245°.

$T = 1911$ October 27.77555 Berlin M. T.
$\omega = 153° 01' 27''.2$
$\Omega = 292\ 56\ 57\ .1$ } 1911.0
$i = 33\ 48\ 12\ .8$
$\log q = 9.689688$
$e = 0.99704$

The Discovery of Comet 1913 *f*.—The sixth comet of 1913 was discovered by the writer at ten o'clock on the night of December 17, 1913, while searching with the eight-inch Zeiss comet-seeker of the La Plata Observatory. When found the comet was very faint, scarcely brighter than the eleventh magnitude. It had a diameter of less than a minute of arc, with a sharply defined central condensation, almost stellar in appearance. No tail was visible, either in the comet-seeker or in the seventeen-inch telescope.

At the time of discovery the comet was about three degrees northeast of the third magnitude star Eta Eridani, in a field containing very few stars, and moving so slowly that its motion was not immediately detected with the comet seeker. It was at once observed by Professor Hussey with the seventeen-inch refractor, giving the following position:

1913 Dec. 17 $14^h\ 26^m\ 36^s$ Gr.M.T.
$\alpha = 3^h\ 3^m\ 19^s.10$ $\delta = -7^\circ\ 25'\ 24''.1$

with a slow motion in a northwesterly direction. Subsequent observations have shown a daily motion of only sixteen minutes of arc along the arc of a great circle.

I have examined the comet on a number of nights since discovery. There has been, I think, a slight increase in brightness.

PAUL T. DELAVAN.

Observatorio Astronomico,
La Plata, Argentina,
December 22, 1913.

NOTES FOR OBSERVERS.

Monthly Report of the American Association of Variable Star Observers, Dec., 1913-Jan., 1914.—The value of coöperative observing in this line of work continues to assert itself. During the past month the weather in some sections of the country has been extremely inclement, and has interfered with the work of many observers. On the contrary, observers elsewhere have been favored with clear skies and have sent in larger lists than usual, so that our average is maintained, and the variables have been consistently observed.

It is a pleasure each month to introduce new members to the Association. Mr. M. Yamasaki, of Redwood City, Cal., has lately joined our ranks. Mr. Yamasaki observes with a 4″ refractor, and as he has had considerable experience in observing he will doubtless render us a valuable service. His observations in the reports will be designated "Ya".

Through delays in the mail, Mr. Huntingtons list for last month failed to reach the secretary in time for the report. It is therefore incorporated in the results of this month's work so that our records may be complete.

Good progress is being made toward the collection of charts for general distribution. During the past week the secretary has traced twenty-eight charts of the neglected variables sent him by Professor Pickering. These are now in the hands of Mr. Bancroft who has charge of the blue printing. Dr. Gray is also preparing a set from Hagen's Atlas which will soon be ready to combine with the set on hand.

In order that all of our members may know the variables that should be especially observed, the list of neglected variables follows. Members are requested to make a copy of this list, and when the charts are distributed they will be able to take up the observation of these stars. For the sake of brevity the designation numbers are omitted.

R, X, RT, RU, RV, SY Aquilae. U, V, X Aurigae. U, Z Boötis. U, W Cancri. T Canis Minoris. Z Coronae. R Corvi. Z, TW, RZ, TY Cygni. T Draconis, V, X, Y, Z Delphini. S, T, V, X Geminorum. R, RS, RT, RU, RY, RZ, SS, SV Herculis. T, V, X Hydrae. V, W Leonis. T Leporis. S, T, Y, RT Librae. Y Monocerotis. S, V, W, X, Z, RR, RT, RU, RY Ophiuchi. S Orionis. S, T, V, Y, X, Z, RR, RS, RT, RW Pegasi. U Persei. S Piscium. S, T Serpentis. R, S, V Tauri. T, V, Y, Z, SU Virginis. U Puppis.

Variable Star Observations Dec., 1913-Jan. 1914.

001032
S Sculptoris

Mo.	Day	Est.	Obs.
12	2	7.9	G
	7	7.7	G
	14	7.0	G
	15	7.3	Ba
	15	6.7	G
	17	6.6	G

001755
T Cassiop.

Mo.	Day	Est.	Obs.
12	3	7.6	Bu
	5	7.8	Ba
	11	7.8	Ba
	11	8.4	M
	15	8.0	M
	18	7.6	Bu
	19	7.9	Ba
	19	8.1	M
	27	7.8	Ba
1	5	8.6	S

001838
R Androm.

Mo.	Day	Est.	Obs.
12	30	11.0	Hu

001909
S Ceti

Mo.	Day	Est.	Obs.
12	30	10.6	S

003179
Y Cephei

Mo.	Day	Est.	Obs.
12	18	12.4	Hu
	19	12.7	Ba
	27	12.8	Ba
	30	12.4	Hu

004435
V Androm.

Mo.	Day	Est.	Obs.
12	3	9.0	Bu
	5	9.9	Ba
	11	10.2	Ba
	15	10.4	Ba
	18	9.2	Bu
	22	11.0	Ba
	27	11.2	Ba
	30	11.0	Hu

004533
RR Androm.

Mo.	Day	Est.	Obs.
12	5	9.8	Ba
	11	9.7	Ba
	15	9.3	Ba
	22	9.2	Ba
	27	9.3	Ba
	30	9.3	Hu

004746
RV Cassiop.

Mo.	Day	Est.	Obs.
11	26	8.6	L
	29	8.9	L
12	9	9.1	L
	15	8.9	Ba
	15	9.3	L

RV Cassiop.

Mo.	Day	Est.	Obs.
12	21	9.3	L
	22	9.3	Ba
	27	9.1	Ba

004958
W Cassiop.

Mo.	Day	Est.	Obs.
12	5	11.1	Ba
	11	10.6	Ba
	15	10.0	Ba
	20	11.4	Br
	22	10.7	Ba
	22	10.7	J
	27	10.6	Ba
	27	10.8	J
	30	10.3	Ba
1	5	10.6	J

010940
U Androm.

Mo.	Day	Est.	Obs.
12	19	11.9	Ba
	22	11.7	Ba
	27	11.3	Ba

011208
S Piscium

Mo.	Day	Est.	Obs.
12	19	11.9	Ba
	27	12.2	Ba

011272
S Cassiop.

Mo.	Day	Est.	Obs.
12	11	11.2	Ba
	15	10.9	M
	27	11.5	Ba

012233 a
R Sculptoris

Mo.	Day	Est.	Obs.
12	2	7.0	G
	7	7.0	G
	15	7.2	G

012350
RZ Persei

Mo.	Day	Est.	Obs.
12	30	13.2	Ba

012502
R Piscium

Mo.	Day	Est.	Obs.
12	15	8.8	M
	15	9.0	O
	22	9.0	O
	27	9.0	O
	30	9.0	S

013238
RU Androm.

Mo.	Day	Est.	Obs.
12	27	11.7	J

013338
Y Androm.

Mo.	Day	Est.	Obs.
11	5	9.5	Ba
12	11	9.1	Ba
	15	8.9	Ba
	22	9.2	Ba
	27	9.0	Ba
	27	9.6	J

014958
X Cassiop.

Mo.	Day	Est.	Obs.
11	26	11.3	L
12	10	11.3	L
	30	11.0	Ba

015254
U Persei

Mo.	Day	Est.	Obs.
12	5	10.7	Ba
	15	10.3	Ba
	22	9.9	Ba
	27	9.6	Ba

021024
R Arietis

Mo.	Day	Est.	Obs.
12	22	11.6	Br

021403
o Ceti

Mo.	Day	Est.	Obs.
11	26	8.9	L
	29	8.9	L
	30	8.9	C
12	1	9.0	Br
	1	8.9	C
	3	8.8	Bu
	11	8.8	L
	15	8.6	G
	15	8.8	L
	15	8.5	Ba
	15	8.8	O
	15	8.8	Br
	15	8.7	M
	17	8.5	C
	18	9.0	Bu
	20	8.8	L
	20	8.8	Br
	20	8.6	O
	21	8.8	St
	22	8.7	L
	22	8.6	O
	23	8.7	Br
	27	8.6	G
	27	8.0	Ba
	27	8.0	O
	28	7.0	C
	29	8.3	O
	30	8.0	Hu

021258
T Persei

Mo.	Day	Est.	Obs.
12	3	9.0	Bu
	18	8.8	Bu

021558
S Persei

Mo.	Day	Est.	Obs.
11	30	9.8	P
12	30	10.0	C
	1	10.0	C
	1	9.4	"
	3	10.0	Bu
	5	9.5	Ba
	15	9.4	Ba
	17	10.4	C

S Persei

Mo.	Day	Est.	Obs.
12	18	10.0	Bu
	22	9.6	Ba
	27	9.6	Ba
	28	10.0	C

022813
U Ceti

Mo.	Day	Est.	Obs.
11	30	7.7	C
12	1	7.7	C
	2	7.1	G
	3	7.4	Bu
	15	7.7	Ba
	17	7.3	G
	17	8.0	C
	18	8.3	O
	18	7.6	Bu
	22	8.3	O
	26	7.6	G
	27	8.5	O
	27	8.4	Ba
	28	8.9	C

023133
R Trianguli

Mo.	Day	Est.	Obs.
12	2	8.1	G
	7	7.8	G
	14	7.5	O
	15	7.5	Ba
	15	7.4	G
	18	7.4	G
	20	7.5	O
	27	7.4	Ba
	29	7.0	O

024356
W Persei

Mo.	Day	Est.	Obs.
11	28	9.8	L
12	1	9.8	Br
	1	9.8	L
	3	9.2	Bu
	4	9.7	V
	5	9.4	M
	5	9.2	Ba
	7	9.8	Br
	9	9.4	M
	9	9.7	L
	12	9.2	Ba
	14	9.7	O
	15	9.1	Ba
	15	10.0	Br
	15	9.7	M
	15	9.5	L
	18	9.0	Hu
	18	9.4	Bu
	20	9.9	Br
	21	9.7	L
	22	9.1	Ba
	22	9.8	M
	22	10.1	Br
	23	10.1	Br
	30	9.0	Ba
	30	9.2	Hu

030514
U Arietis

Mo.	Day	Est.	Obs.
12	3	13.7	Ba
	15	13.2	Ba
	19	13.0	Ba
	27	12.8	Ba

031401
X Ceti

Mo.	Day	Est.	Obs.
12	30	8.8	Ba
	30	9.1	O

032043
Y Persei

Mo.	Day	Est.	Obs.
11	30	10.0	P
12	1	9.9	Ma
	1	9.9	G
	3	9.8	Ba
	3	10.4	Bu
	5	10.1	Ba
	5	10.1	M
	7	9.8	G
	9	10.2	M
	11	9.8	Ba
	12	9.8	Ba
	15	10.2	G
	15	9.9	Ba
	18	10.7	Bu
	18	10.1	O
	18	10.0	Hu
	19	10.1	Ba
	22	10.4	M
	22	9.8	Ba
	27	9.8	Ba
	30	9.8	Ba

032335
R Persei

Mo.	Day	Est.	Obs.
12	3	10.0	Ba
	15	9.2	Ba
	22	9.0	Ba
	27	8.7	Ba
	30	9.1	S

033362
U Camelop.

Mo.	Day	Est.	Obs.
12	1	8.0	Br
	3	7.7	Ba
	7	7.9	Br
	12	7.4	Ba
	15	7.8	Br
	20	7.8	Br
	21	7.6	Br
	22	7.6	Ba
	22	7.6	Br
	27	7.6	Ba

035915
V Eridani

Mo.	Day	Est.	Obs.
12	12	9.2	Ba
	30	9.3	Ba

VARIABLE STAR OBSERVATIONS Dec., 1913-Jan., 1914.—Continued.

042215
W Tauri

Mo.	Day	Est.	Obs.
12	1	8.6	G
	3	9.7	Bu
	3	8.6	G
	3	9.0	Ba
	5	9.0	M
	9	9.0	B
	11	8.8	Ba
	11	8.8	B
	14	8.6	G
	15	8.8	M
	15	8.9	B
	15	8.7	Ba
	15	8.5	G
	15	9.3	O
	17	8.8	C
	17	8.4	G
	18	9.4	Bu
	18	9.0	O
	19	8.8	B
	19	8.7	M
	22	8.8	M
	22	8.8	Ba
	22	8.9	O
	26	8.4	G
	27	8.8	O
	27	8.7	Ba
	29	8.5	O
	30	8.8	B
	31	9.0	M
1	5	8.6	O

043208
RX Tauri

Mo.	Day	Est.	Obs.
12	3	12.5	Ba
	9	12.1	B
	19	12.0	B
	30	11.7	B
	30	11.8	Ba

043274
X Camelop.

Mo.	Day	Est.	Obs.
11	28	8.7	L
12	1	8.9	L
	3	8.7	Ba
	9	8.8	L
	14	9.0	O
	15	9.0	Ba
	15	9.1	L
	18	9.5	O
	20	9.5	O
	21	9.2	L
	22	9.8	O
	27	10.3	O
	28	10.4	O
	29	10.4	O
	30	10.5	O
	30	10.4	Ba

045307
R Orionis

Mo.	Day	Est.	Obs.
12	3	12.5	Ba
	27	11.7	Ba

045514
R Leporis

Mo.	Day	Est.	Obs.
11	26	9.1	L
	29	9.2	L
12	1	8.4	G
	3	7.8	Ba
	3	7.6	Bu
	7	8.3	G
	15	7.7	Ba
	17	8.5	G
	18	7.4	Bu
	20	9.3	L
	26	8.5	G
	27	7.6	Ba

050953
R Aurigae

Mo.	Day	Est.	Obs.
12	3	8.4	Bu
	3	9.0	Ba
	9	8.8	M
	15	8.8	Ba
	18	8.6	Bu
	18	8.7	O
	19	8.6	M
	27	8.6	Ba

052034
S Aurigæ

Mo.	Day	Est.	Obs.
11	28	10.2	L
12	1	10.3	L
	15	9.1	Ba
	19	9.9	O
	22	10.8	L
	30	10.1	O
	30	9.3	Ba

052036
W Aurigæ

Mo.	Day	Est.	Obs.
12	3	12.7	Ba
	27	11.9	Ba
	30	11.6	Ba

052404
S Orionis

Mo.	Day	Est.	Obs.
12	2	10.0	G
	17	10.4	G

054920
U Orionis

Mo.	Day	Est.	Obs.
11	30	11.6	L
12	9	10.9	L
	20	11.0	L
	27	11.9	Hu
	30	11.2	Hu

060450
X Aurigae

Mo.	Day	Est.	Obs.
12	3	11.6	Ba
	30	13.2	Ba

061702
V Monoc.

Mo.	Day	Est.	Obs.
12	3	10.5	Ba
	15	10.0	Ba
	22	10.2	Ba
	27	10.2	Ba

062908
RW Monoc.

Mo.	Day	Est.	Obs.
12	30	9.1	O

063159
U Lyncis

Mo.	Day	Est.	Obs.
12	30	13.8	Ba

064030
X Geminorum

Mo.	Day	Est.	Obs.
12	28	11.4	O

064922
NOVA GEMIN.

Mo.	Day	Est.	Obs.
11	26	10.4	L
	28	10.8	L
12	1	10.8	L
	2	11.0	G
	3	10.8	Bu
	3	10.6	Ba
	5	10.6	L
	17	10.9	G
	18	10.9	O
	18	11.2	Bu
	20	10.8	L
	26	11.0	G
	30	10.7	Ba

065208
X Monoc.

Mo.	Day	Est.	Obs.
11	27	8.4	L
12	3	8.4	Ba
	5	9.0	L
	11	9.4	L
	12	8.9	Ba
	15	8.8	Ba
	17	8.7	G
	22	9.0	L
	22	9.2	Ba
	26	8.8	G
	28	8.9	Ba

065355
R Lyncis

Mo.	Day	Est.	Obs.
12	30	10.2	Ba

070122
R Gemin.

Mo.	Day	Est.	Obs.
12	27	9.5	Hu

070310
R Can. Min.

Mo.	Day	Est.	Obs.
11	27	8.8	L
12	3	8.3	Ba
	5	9.0	L
	11	8.6	Ba
	21	9.1	L
	26	9.1	G
	30	8.8	Ba

072708
S Can. Min.

Mo.	Day	Est.	Obs.
11	26	10.3	L
	30	10.2	L
12	1	10.3	G
	8	10.0	M
	8	10.1	L
	11	10.1	L
	17	9.7	G
	22	9.5	L
	26	8.9	G
	29	8.8	O
	31	8.8	M
1	5	8.7	S

073508
U Can. Min.

Mo.	Day	Est.	Obs.
11	26	8.8	L
	30	8.9	L
12	3	8.5	Ba
	9	8.9	L
	11	8.5	Ba
	17	8.7	G
	21	9.1	L
	22	8.7	Ba
	28	9.0	Ba

074922
U Gemin.

Mo.	Day	Est.	Obs.
11	26	9.2	L
	27	9.1	L
	28	9.1	L
	29	9.3	L
	30	9.2	L
12	3	9.7	Ba
	3	9.6	Bu
	5	10.0	Ba
	5	10.2	Ba
	5	9.9	L
	8	12.4	L

081112
R Cancri

Mo.	Day	Est.	Obs.
11	28	11.1	L
	30	10.8	L
12	3	10.7	Ba
	9	11.0	L
	19	11.0	Ba
	28	11.4	Ba

081633
T Lyncis

Mo.	Day	Est.	Obs.
12	1	10.7	G
	17	10.4	G

082405
RT Hydrae

Mo.	Day	Est.	Obs.
11	27	8.6	L
12	5	8.3	L
	9	8.2	L
	21	8.1	L
	30	8.0	Ba

085120
T Cancri

Mo.	Day	Est.	Obs.
11	28	9.7	L
12	5	9.1	Ba
	9	.94	L
	19	8.3	Ba
	22	9.3	L
	28	8.3	Ba

090425
W Cancri

Mo.	Day	Est.	Obs.
12	19	12.4	Ba
	30	12.2	Ba

093934
R Leo. Min.

Mo.	Day	Est.	Obs.
1	5	7.0	S

094211
R Leonis

Mo.	Day	Est.	Obs.
11	26	9.6	L
	28	9.6	L
12	3	8.9	Ba
	5	9.5	L
	8	9.2	M
	11	9.4	L
	12	8.6	Ba
	28	7.4	Ba
1	5	7.0	S

103012
U Hydrae

Mo.	Day	Est.	Obs.
11	30	4.7	L
12	9	4.6	L
	21	4.8	L

103769
R Urs. Maj.

Mo.	Day	Est.	Obs.
12	3	12.4	Ba
	19	12.6	Ba
	27	12.9	Ba
	30	12.8	B

104620
V Hydrae

Mo.	Day	Est.	Obs.
12	28	8.1	Ba

122001
SS Virginis

Mo.	Day	Est.	Obs.
12	28	6.0	Ba

123160
T Urs. Maj.

Mo.	Day	Est.	Obs.
12	3	12.0	Ba
	19	12.5	Ba
	27	12.8	Ba

123307
R Virginis

Mo.	Day	Est.	Obs.
12	28	7.9	Ba

VARIABLE STAR OBSERVATIONS Dec., 1913-Jan., 1914.

123961
S Urs. Maj.

Mo.	Day	Est.	Obs.
11	26	10.5	L
12	3	10.6	Bu
	3	10.8	Ba
	5	10.6	L
	13	11.0	M
	18	11.0	Bu
	19	11.0	Ba
	21	10.6	L
	23	11.2	Br
	27	10.7	Ba
	30	10.5	Ba

132422
R Hydrae

11	26	7.9	L
	30	7.8	L
12	9	7.7	L
	11	7.7	L
	21	7.6	L

132706
S Virginis

11	26	8.2	L
	30	7.6	L
12	5	7.5	L
	10	7.3	L
	21	6.8	L

133273
T Urs. Min.

12	1	10.0	G
	3	10.0	G
	15	9.6	G

133674
V Urs. Min.

12	1	7.8	G
	3	7.8	G
	15	7.7	G

134440
R Can. Ven.

12	9	12.0	L
	13	11.8	M
	21	11.7	L
	28	10.4	Ba

141567
U Urs. Min.

12	3	9.8	Bu
	12	9.8	Ba
	15	9.8	Ba
	15	9.3	B
	18	9.4	Bu
	19	9.5	Ba
	28	9.3	Ba
	30	9.0	S

141954
S Boötis

12	28	11.9	Ba

142539
V Boötis

Mo.	Day	Est.	Obs.
11	26	9.1	L
	30	9.3	L
12	9	9.7	L
	13	9.5	M
	15	9.7	M
	21	10.3	L

142584
R Camelop.

12	6	11.3	B
	16	10.5	L
	18	10.4	O
	21	9.9	L
	22	10.3	O
	27	10.1	O
	28	9.5	Ba
	29	10.0	O
	30	9.6	B
	30	10.1	O
1	5	9.5	O

143227
R Boötis

	26	10.1	V
	30	9.7	L
12	8	9.3	L
	10	9.2	L
	13	9.1	M
	14	9.0	M
	21	8.5	L
	28	7.6	Ba

150605
Y Librae

12	9	9.8	L

153378
S Urs. Min.

11	28	9.8	L
12	1	9.8	L
	1	9.3	G
	3	10.3	Ba
	3	9.0	Bu
	6	9.6	B
	10	10.3	L
	16	10.2	L
	18	9.4	Bu
	28	10.4	Ba

154428
R Cor. Bor.

11	9	6.4	H
	12	6.2	H
12	5	5.9	L
	9	5.9	L
	10	5.9	L
	13	5.5	M

155947
X Herculis

Mo.	Day	Est.	Obs.
11	7	6.4	H
	8	6.3	H
	12	6.4	H
	16	6.6	H
	30	6.4	L
12	11	5.9	L
	15	6.0	L
	21	6.1	L

162119
U Herculis

11	9	11.2	H
	12	11.5	H

163172
R Urs. Min.

12	5	9.5	Ba
	6	9.2	B
	15	9.2	B
	15	10.0	O
	28	9.5	Ba

163266
R Draconis

11	7	11.8	H
12	6	12.3	B

175458
T Draconis

12	18	11.2	V

180565
W Draconis

12	5	10.8	Ba
	19	11.1	Ba
	27	11.5	Ba

180531
T Herculis

11	7	8.0	H
	9	7.4	H
	12	7.8	H
	16	7.8	H
	26	8.5	L
	28	8.8	L
	30	9.3	C
12	1	9.2	L
	1	9.2	C
	1	9.0	G
	8	9.5	L
	9	9.5	St
	11	9.5	L
	16	9.8	L
	21	10.4	L

181136
W Lyrae

11	30	8.9	C
12	1	8.9	C
	1	9.1	G

W Lyrae

Mo.	Day	Est.	Obs.
12	5	8.7	M
	11	8.5	B
	17	8.7	C
	19	8.7	M
	28	8.9	C

184205
R Scuti

11	28	6.8	L
	29	7.1	L
	30	6.9	L
	30	7.5	C
12	1	6.9	C
	7	6.5	Br
	8	6.2	L
	9	6.1	L
	11	6.0	L
	15	5.8	L
	21	5.8	L

190108
R Aquilae

12	15	6.6	G
	17	6.3	G

190926
X Lyrae

12	5	9.3	Ba
	19	9.2	Ba

191033
RY Sagittarii

11	9	10.3	H
	19	10.7	H

191350
TZ Cygni

11	28	10.8	L
12	21	10.5	L

191637
U Lyrae

12	5	9.8	Ba
	19	8.7	Ba

193449
R Cygni

12	11	11.9	B
	15	12.0	Ba
	19	11.7	Ba
	19	11.0	B
	21	11.8	L
	22	11.6	Ba
	27	11.5	Ba

193732
TT Cygni

11	26	8.1	L
	30	8.1	L
	30	8.1	P
	30	8.3	C

TT Cygni

Mo.	Day	Est.	Obs.
12	1	8.2	C
	5	7.7	Ba
	11	8.3	L
	14	7.6	G
	17	8.3	C
	19	7.7	B
	28	8.3	C
	28	8.2	P

194048
RT Cygni

12	1	11.0	G
	5	10.5	Ba
	11	10.8	B
	13	11.3	Ba
	19	10.9	B
	19	11.5	Ba
	22	11.5	Ba
	27	11.1	Ba

194348
TU Cygni

12	8	11.0	L
	13	11.8	Ba
	19	11.4	Ba
	21	10.8	L
	22	11.0	Ba
	27	10.8	Ba

194632
χ Cygni

11	16	5.4	H
	25	5.3	P
	26	5.2	L
	28	5.2	L
	30	5.2	L
	30	5.5	P
	30	5.7	C
12	1	5.8	C
	1	4.9	Ma
	5	5.4	M
	8	5.4	L
	11	5.5	L
	11	5.7	B
	12	6.0	P
	13	5.9	Ba
	14	6.2	H
	14	6.4	St
	14	6.5	O
	14	5.6	Ma
	14	6.3	G
	15	6.4	O
	15	5.8	L
	17	6.5	C
	18	6.7	O
	19	6.8	Ma
	19	6.7	B
	19	6.5	M
	19	6.2	Ba
	19	6.4	H

VARIABLE STAR OBSERVATIONS Dec., 1913-Jan., 1914.—Continued.

χ Cygni

Mo.	Day	Est.	Obs.
12	19	6.7	O
	20	6.2	H
	20	6.7	O
	21	6.0	L
	21	6.4	St
	22	6.4	Ba
	22	7.0	O
	27	6.8	Ba
	27	7.0	O
	28	7.1	C
	28	6.9	P
	29	7.3	O
	30	7.5	O

195849
Z Cygni

Mo.	Day	Est.	Obs.
12	1	8.8	G
	18	9.4	G

200647
SV Cygni

Mo.	Day	Est.	Obs.
11	26	9.3	L
	30	9.4	L
	30	9.0	C
12	1	8.9	Ma
	1	9.0	C
	1	9.2	G
	5	8.8	Ba
	9	8.8	M
	11	8.6	B
	11	9.4	L
	14	9.2	G
	15	9.4	L
	17	9.2	C
	19	8.9	B
	19	9.0	Ba
	19	9.4	M
	20	9.1	H
	27	8.5	Ba
	28	9.2	C
	30	8.9	B

200715 a
S Aquilae

Mo.	Day	Est.	Obs.
12	7	9.4	G
	11	9.5	B
	17	9.6	G

200715 b
RW Aquilae

Mo.	Day	Est.	Obs.
12	11	9.2	B

200916
R Sagittae

Mo.	Day	Est.	Obs.
12	7	9.3	G
	11	8.9	B
	17	8.9	G

200938
RS Cygni

Mo.	Day	Est.	Obs.
11	26	7.3	L
	30	7.4	L
	30	7.4	C
12	1	7.4	C
	1	7.8	Ma
	5	7.4	Ba
	11	7.3	L
	12	7.9	P
	14	7.8	Ma
	17	7.4	C
	18	7.8	G
	19	7.8	Ma
	19	7.5	Ba
	20	7.6	O
	22	8.2	L
	27	7.4	Ba
	27	7.7	G
	28	7.5	C

201008
R Delphini

Mo.	Day	Est.	Obs.
12	14	8.9	O
	18	9.0	V
	20	9.3	O

201121
RT Capricorni

Mo.	Day	Est.	Obs.
11	28	7.8	L
12	1	7.7	L
	11	7.9	L
	15	7.7	L
	21	7.6	L

201647
U Cygni

Mo.	Day	Est.	Obs.
11	26	9.6	L
	30	9.6	L
12	1	9.6	G
	9	9.0	M
	11	9.9	L
	14	9.5	G
	19	8.6	M

202539
RW Cygni

Mo.	Day	Est.	Obs.
12	3	8.1	G
	5	8.1	Ba
	5	8.6	M
	7	8.2	G
	9	8.5	M
	11	8.1	G
	12	8.5	P
	14	8.3	G
	15	8.6	M
	17	8.6	G
	18	8.5	G
	19	8.4	M
	19	8.1	Ba
	20	8.6	H
	27	8.4	G
	27	9.0	P
	27	8.0	Ba

202946
SZ Cygni

Mo.	Day	Est.	Obs.
11	25	9.2	P
	30	9.0	P
	30	9.6	C
12	1	9.8	C
	3	9.3	P
	3	9.5	Ba
	5	10.0	Ba
	5	9.6	M
	8	9.4	Le
	11	9.0	Le
	11	8.8	B
	11	8.6	Ba
	12	8.7	Ba
	13	8.9	Ba
	14	9.4	Le
	15	9.2	Ba
	16	9.5	Le
	17	9.6	C
	17	9.5	Le
	19	9.3	M
	19	9.8	B
	19	9.8	Ba
	19	9.5	H
	20	9.9	Ba
	20	9.7	H
	21	9.8	Br
	21	9.6	Le
	22	9.7	Ba
	27	8.9	Ba
	27	9.2	P
	30	9.0	Ba
	30	9.0	B

202954
ST Cygni

Mo.	Day	Est.	Obs.
12	5	10.5	Ba
	15	9.9	Ba
	22	9.9	Ba
	27	10.2	Ba

203847
V Cygni

Mo.	Day	Est.	Obs.
12	1	11.2	G

203816
S Delphini

Mo.	Day	Est.	Obs.
12	17	9.9	G

204016
T Delphini

Mo.	Day	Est.	Obs.
12	15	9.7	G

205923
R Vulpeculae

Mo.	Day	Est.	Obs.
12	21	9.7	L

210116
RS Capricorni

Mo.	Day	Est.	Obs.
11	30	8.4	C
12	1	8.4	C
	17	8.4	C
	28	8.4	C

210868
T Cephei

Mo.	Day	Est.	Obs.
11	26	6.2	L
	29	6.4	L
	30	6.8	C
12	1	6.8	C
	1	6.0	Ma
	3	6.7	Bu
	4	6.8	V
	5	6.5	L
	5	6.6	Ba
	10	6.5	L
	11	6.7	Ba
	14	6.8	Ma
	15	6.7	O
	15	6.5	L
	17	6.5	G
	97	7.1	C
	18	6.8	Bu
	19	6.9	V
	19	6.8	Ba
	19	6.9	Ma
	21	6.5	L
	22	6.9	M
	23	6.9	Br
	27	6.9	Ba
	27	7.1	O
	27	7.8	P
	29	7.1	O
	30	7.9	P
1	5	7.8	S
	5	7.5	O

213044
W Cygni

Mo.	Day	Est.	Obs.
11	26	5.3	L
	29	5.1	L
	30	6.0	C
12	1	5.9	C
	8	5.2	L
	11	5.3	L
	15	5.4	L
	17	6.1	C
	18	5.8	G
	20	5.4	L
	22	5.4	L
	28	6.2	C

213678
S Cephei

Mo.	Day	Est.	Obs.
12	4	9.5	V
	5	8.8	Ba
	19	8.9	Ba
	22	9.8	M
	26	10.0	V
	27	9.0	Ba
1	5	10.5	S

213753
RU Cygni

Mo.	Day	Est.	Obs.
12	1	8.8	G
	4	8.6	V
	18	8.7	G
	18	8.5	O

RU Cygni

Mo.	Day	Est.	Obs.
12	19	8.6	V
	20	8.4	O
	20	8.7	G
	27	8.7	G
	27	8.4	O
1	5	8.4	O

213843
SS Cygni

Mo.	Day	Est.	Obs.
11	7	9.7	H
	26	11.8	L
	29	12.0	L
12	3	12.0	Ba
	5	12.0	Ba
	8	11.8	L
	11	12.0	Ba
	12	12.0	Ba
	13	12.0	Ba
	15	12.0	Ba
	15	11.9	L
	16	11.9	L
	17	11.9	Le
	19	11.4	B
	19	12.0	Ba
	20	12.0	L
	20	11.8	Br
	21	11.9	L
	22	12.0	L
	22	12.0	Ba
	22	12.1	J
	23	11.8	Br
	27	12.0	Ba
	27	12.3	J
	30	11.3	Hu
	30	11.8	B
	30	11.9	Ba
1	5	12.0	J

213937
RV Cygni

Mo.	Day	Est.	Obs.
11	26	6.9	L
	30	8.1	C
12	1	7.0	Ma
	1	8.1	C
	1	6.8	L
	3	8.1	P
	5	7.0	Ba
	5	7.6	M
	11	6.8	L
	12	7.8	P
	17	8.1	C
	18	6.8	O
	19	7.0	B
	19	7.2	Ma
	19	7.4	Ba
	19	7.6	M
	20	6.8	O
	27	6.8	Ba
	27	6.5	O
	27	7.2	G
	28	8.1	C

VARIABLE STAR OBSERVATIONS Dec., 1913-Jan., 1914—Continued

222439
S Lacertae

Mo.	Day	Est.	Obs.
12	22	11.0	O

230110
R Pegasi

Mo.	Day	Est.	Obs.
11	28	7.9	L
12	1	8.2	L
	1	8.2	Br
	3	8.4	Bu
	7	8.3	Br
	9	8.0	St
	11	8.5	L
	11	8.0	St
	11	8.4	G
	14	8.3	G
	14	8.4	O
	15	8.4	Br
	18	8.2	Bu
	18	8.9	O
	18	8.6	G
	20	9.1	Br
	20	9.0	O
	21	9.0	St
	21	9.1	Br

R Pegasi

Mo.	Day	Est.	Obs.
12	21	9.2	L
	22	9.0	M
	22	9.3	Br
	23	9.4	Br
	27	9.0	O
	29	9.1	O
	30	9.0	P
	30	9.3	O

230759
V Cassiopeiae

Mo.	Day	Est.	Obs.
12	4	8.0	V
	5	7.7	Ba
	11	7.7	Ba
	15	8.1	O
	19	8.0	Ba
	22	8.1	Ba
	22	8.0	O
	22	8.0	M
	26	8.0	V
	27	8.0	P
	27	8.0	O
	27	8.3	Ba

V Cassiopeiae

Mo.	Day	Est.	Obs.
12	29	8.3	P
	29	8.1	O
	30	8.6	O
	30	8.3	P
1	5	8.5	O

231425
W Pegasi

Mo.	Day	Est.	Obs.
12	12	11.8	Ba
	19	11.7	Ba
	27	11.7	Ba

231508
S Pegasi

Mo.	Day	Est.	Obs.
12	19	10.8	Ba
	22	10.8	Ba

233335
ST Androm.

Mo.	Day	Est.	Obs.
12	3	9.0	Bu
	5	9.2	Ba
	11	9.2	Ba

ST Androm.

Mo.	Day	Est.	Obs.
12	15	9.3	Ba
	15	9.2	B
	18	9.0	Bu
	19	9.3	Ba
	22	9.4	O
	22	9.3	Ba
	27	9.4	Ba
	30	10.2	P
1	5	9.8	S

233815
R Aquari

Mo.	Day	Est.	Obs.
12	15	9.3	Ba
	30	9.3	Ba

235182
V Cephei

Mo.	Day	Est.	Obs.
11	26	6.7	L
	30	6.8	C
12	1	6.8	C
	17	6.6	C

235209
V Ceti

Mo.	Day	Est.	Obs.
12	2	9.6	G

235350
R Cassiop.

Mo.	Day	Est.	Obs.
11	26	10.0	L
	29	10.0	L
	30	9.8	C
12	3	10.2	Bu
	18	10.2	Bu
	21	11.2	L

235939
SV Androm.

Mo.	Day	Est.	Obs.
12	5	10.3	Ba
	15	10.5	Ba
	22	11.1	Ba
	27	11.4	Ba

No. of observations, 948; No. of stars observed, 135; No. of observers, 18.

Mr. Bancroft leads the class this month with a total of 260 observations of 85 variables, an enviable record. Mr. Lacchini sent in 195 estimates, good indication of clear skies in Italy during the past month, and earnest work on his part. It is gratifying to note the good progress some of our new members are making. Mr. Putnam in particular deserves credit for his list of 26 observations of 11 stars, his first contribution to the reports.

The variable 074922 U Geminorum rose November 26, and remained bright for four or five days. The maximum was observed by Messrs. Bancroft, Burbeck, Hunter and Lacchini. As the period ranges from 71 to 126 days this star should be closely observed subsequent to the first week in February.

Dr. Hartwig calculated a maximum for the following variables during the month:

Dec.	8	*022813* U Ceti.
	11	213553 RU Cygni
	21	072708 S Can. Min.
	22	230759 V Cassiop.
	27	023133 R Triang.

A reference to the observations of these stars is of special interest.

It is hoped that some of the members of the New Bedford Astronomical Society, lately formed, will join our association. We offer all observers a splendid opportunity to engage in practical telescopic work.

During the past month 14 variables on the neglected list have been observed, and 38 estimates secured.

To facilitate the identification of contributors to the reports the names of all who send in lists will appear each month. Those contributing this month are as follows:

Messrs. Bancroft, Bouton, Bruseth, Burbeck, Craig, Gray, Hunter, Huntington, Jacobs, Lacchini, Leonard, Mach, McAteer, Olcott, Putnam, Stepka, Vrooman, and Miss Swartz.

WILLIAM TYLER OLCOTT.
Corresponding Secretary.

Norwich, Conn., Jan. 10, 1913.

COMMUNICATIONS.

Mars and its Canals.—The canals on Mars are not dug. One thing which will do much to dispel the mystifying feeling, which the enormousness of the canals impresses on the mind, and which inclines one to reject them as a reality, is the realization that they are not dug. They are walled, or made between two walls on the surface of the ground as they have to be higher than the vast fields on each side, which they are intended to irrigate. So it costs no more to build up the walls of a canal 20 or 40 miles wide than it would to build one only one mile wide, and covers a much larger area of land, which was the object in view in the plan of their construction, to give them more capacities. The canals are artificial rivers.

The service of the canals is to bring from one pole or the other, according to season, the snow water, and to take it all along, some of it even as far as the equator, to give the soil everywhere the necessary moisture.

During the period the polar water is conveyed, the canals are visible. But after the water from the big canals is emptied in a multitude of small cross country canals or ditches, to take the liquid wherever it is wanted, then the canals disappear. They disappear because water in long streaks, which makes their visibility possible, is gone and the canals are themselves cultivated during the second part of Mars' long summer. The fact of their appearance and disappearance proves their existence. Schiaparelli, Flammarion, Percival Lowell and many others testify, as a result of their observations, that the canals alternately appear and disappear. When visible, they are visible for all the observatories where there are powerful eyes to observe and a clear atmosphere to permit observation. And when they become invisible they are invisible also to all.

The poles on Mars, according to what is well recognized in astronomy, turn white during Mars' long winter, and dark in summer. One year on Mars is as long as two years on earth, but the days are about the same on both planets.

A dark belt forms itself around the poles of Mars when the snow is melting. The same dark line has been observed by many astronomers, among them Rev. T. E. R. Phillips, who said concerning this: "The melting cap is always girdled by an intensely narrow dark line. This is not seen when the cap is forming." On that subject Professor James Beikie remarks: "It is hard to believe that this is anything than the result of the melting of polar snows." Further in his book "The Telescope" page 134 and 145, he made the following highly notable observation: "Viewed with a telescope of considerable power the polar caps sometimes present the effect of projecting above the general level of the planet."

This observation of Professor Beike will lead anyone, who does not doubt the existence of the canals, to believe that when they were constructed, very naturally, a slight inclination was given to them from the poles toward the equator, to enable water to propel itself. To that end the area of the poles had to be heightened where it was necessary so as to stand above the canal level.

Professor Percival Lowell, from whom more knowledge of Mars is due than from any others, remarks in his book "Mars the Abode of Life" page 81: "It (the cap) is seen to be girdled about by a dark blue band, deeper in tone than any other blue green area on the disk. This belt developed the peculiar property of retreating with the cap as the latter shrank, maintaining throughout its attendant post."

What will, possibly, explain the phenomenon of the water (apparently retreating) with the cap is this. There must exist around the poles of Mars a number of walls or dams, encircling the poles as hoops encircle a barrel; so as to withold or retain the

surplus of the water or all the water, when necessary, until the time some of the canals, or all of them, are ready to receive it. As those inclosures are opened, one after another, to let out the liquid, it gives the mind the impression that the water is retreating because new water beyond other inclosures nearer the pole is forming as the season advances.

These circular dams were absolutely necessary to protect the planet from disasters, liable to follow a long spell of warm weather, letting loose suddenly too much water at one pole or the other.

Objections have been made to the idea that Mars is inhabited, on the ground that the planet is too far away from the sun. But conditions are different on Mars. A thin atmosphere does not allow clouds to form, as the air is not heavy enough to over balance the weight of moisture. So the rays of the sun are never impaired in their effect. The hottest days on earth are when the weather is clear, so on Mars where it is always "fair weather" with transparent evaporation, most beneficent to vegetation, as it impregnates the air near the soil, returning in the course of the night, in the form of dew, the heat absorbed through the process of evaporation during the day.

Now according to all the observations, corroborated by other like observations, the canals on Mars exist. And with their existence and the accessory stupendous work that had to be done to accomplish their purpose, is disclosed to the mind a heaping up of amazing wonders reaching even beyond the dream. The mountains on Mars have been taken down; its rivers dammed or canalized; and the sea in which no more water was permitted to run has been left to evaporate itself, adding to the volume of fresh water. And the whole planet from pole to pole has been remodeled and leveled on the basis of water gravity. The poles from which, at times, the snows all disappear, have been refashioned and made high enough, and the canals abutting at the poles, also high enough so the water could flow down grade as far as the equator.

And thus Mars has been transfigurated into a gigantic garden where, it can be conjectured, the most economic and intensive cultivation is the order. While the institutions of Mars must have developed ages ago, to be those of a Heaven, a real Heaven in which all is Union, Science and Harmony.

NARCISSE ST PIERRE.

GENERAL NOTES.

The Astronomical and Astrophysical Society of America held its winter meetings at Atlanta in connection with the meetings of the American Association for the Advancement of Science from December 29 to January 2. The special meetings of the society were held at the Georgia School of Technology and at the Piedmont Hotel. The number of members in attendance was rather small but a large number of interesting and important papers were read. A detailed report of these meetings will appear in the next issue of POPULAR ASTRONOMY.

Professor Winslow Upton, professor of astronomy in Brown University and director of the Ladd Observatory, died of pneumonia on January 8. An account of his life and work will appear in our next issue.

Dr. Seth C. Chandler, formerly editor of the *Astronomical Journal*, and more recently associate editor, died at his home in Wellesley Hills, Mass., on December 31, 1913. We hope to give an account of his career in a later number of POPULAR ASTRONOMY.

Professor J. A. Parkhurst, who went to Europe last summer to attend the astronomical meetings at Bonn and at Heidelberg, and who since that time has been visiting the larger European observatories, spending several weeks at Potsdam, returned to America on January 7. On January 13 Professor Parkhurst delivered a lecture on astronomy at Mt. Holyoke College, and on January 14 at Smith College. He visited the Princeton and the Allegheny Observatories while in the east and will arrive at the Yerkes Observatory about February 1. Professor Parkhurst was accompanied by Mrs. Parkhurst, his niece, Miss Bateman, and Miss Fillmore.

Professor H. H. Turner, Savilian Professor of Astronomy in the University of Oxford, recently delivered the eighty-eighth course of Christmas lectures given under the auspices of the Royal Institution of Great Britain. The course was entitled "A Voyage in Space." The lectures were illustrated and adapted to a juvenile audience. The dates and individual lectures were as follows: December 27, The Starting Point—Our Earth; December 30, The Start through the Air; January 1, Journeying by Telescope; January 3, Visits to the Moon and the Planets; January 6, Our Sun; January 8, The Stars.

Recent News Concerning Mars.—The Lowell Observatory has discovered that the Martian zero meridian, the Greenwich of Mars, passes the center of the disk 12 minutes ahead of the time predicted for it in the planet's ephemeris. So large a discrepancy between the received and the real time of passage cannot be due to error in the position of the axis of rotation of Mars, inasmuch as if any such existed, even to the extent of a degree and a half, it would affect the time of passage by a few seconds only. The discrepancy may possibly be due to an error in the accepted rotation period of the planet, or in other words the day of Mars may be slightly different in duration from what has hitherto been supposed. The ephemeris value of the length of the planet's day dates from before the time of the Lowell Observatory observations and is the only fundamental datum not hitherto revised by it.

Lowell Observatory,
Flagstaff, Arizona, Jan. 9, 1914.

The Observers of the Lowell Observatory have noted the beginning of the Martian south polar cap to take place in the same curious manner as in 1911, by the deposition of sparse patches of hoar-frost like diamond points stippled over certain regions in latitude 60° longitude 30° and latitude 58° longitude 60°, quite unlike the aspect of the snow round its north pole, which is a solid field of white now in process of melting at its edge.

Lowell Observatory,
Flagstaff, Arizona, Jan. 13, 1914.

The 30-inch Allegheny Telescope.—Professor Schlesinger writes that the completion of the 30-inch photographic refractor of the Allegheny Observatory has long been delayed by the failure to secure suitable glass disks. These have now been delivered to the Brashear Company by Schott and Company of Jena, Germany, and it is expected that the telescope will be in use by the early fall.

French Astronomers here for Tests.—Eloi Viennet, the French Astronomer; Achille Auverney, and Richard Coffman, members of the Franco-American Commission of scientists engaged in determining the exact difference in longitude between Paris and Washington by wireless time flashes between Arlington and Eiffel Tower stations, arrived here yesterday on the French steamer Lorraine from Havre. They are changing places with the scientists who have been conducting experiments at Arlington.

New York Times, Sunday, Jan. 11, 1914.

Resumé of Sunspot Observations 1913.

Month	No. of Obs.	Days without	North of equator No. groups	North of equator Av. Lat.	South of equator No. groups	South of equator Av. Lat.	Av. No. at each Obs.	New Groups
Jan.	15	13	0	...	2	−16.5°	0.13	2
Feb.	20	15	1	+30°	0	...	0.25	1
Mar.	14	14	0	...	0	...	0.00	0
Apr.	19	18	0	...	1	5	0.05	1
May	20	20	0	...	0	...	0.00	0
June	9	9	0	...	0	...	0.00	0
Sept.	9	9	0	...	0	...	0.00	0
Oct.	14	14	1	17	0	...	0.14	1
Nov.	16	16	0	...	0	...	0.00	0
Dec.	9	4	1	5	1	−18	1.00	2
Total	147	132	3		4			7

Average number at each observation 0.13
Average latitude of spots north of equator .....+17°.3
Average latitude of spots south of equator .....−16°.0

Spots were found upon only 15 of the 147 days when the sun's surface was observed.

Most of the observations from January to June were made by Miss Louise F. Jenkins, those from September to December by Dr. Anna D. Lewis.

ANNE SEWELL YOUNG.

Mount Holyoke College.

The Number of the Nebulae.—In the *Astronomical Journal* Professor A. E. Fath, Director Smith Observatory, Beloit, Wis., gives the results of a study of the nebulæ found upon photographic plates of 139 regions of the sky, taken with the sixty-inch reflector of the Mount Wilson Solar Observatory during the years 1909-12. The plates form a portion of the work on Kapteyn's "Selected Areas", including all the regions from the north pole to 15° south declination. The exposed area of each plate was 1.88 square degrees. Mr. Fath gives a list of 864 new nebulæ found upon the plates.

In discussing the number of nebulæ which would be found if the whole sky were photographed in the same way, he finds an average of 7.4 nebulæ per plate and, as it would take nearly 22,000 plates of the size used to cover the entire sky, total number comes out about 162,000. This differs widely from Dr. Perrine's estimate of 500,000, based upon 104 plates of the Keeler program with the Crossley reflector of the Lick Observatory. As in two regions which were photographed both at Mt. Wilson and at the Lick Observatory the number of nebulæ comes out practically the same, Mr. Fath concludes that the discrepancy is not to be accounted for by the difference in the instruments and lengths of exposure. He finds a possible explanation in the fact that 33 per cent of the Crossley plates were taken within 45° of the north galactic pole, while only 20 per cent of the "Selected Areas" are found within that region. Another suggestive point is that Keeler's program was apparently to photograph the larger nebulæ and clusters, and it may be that the small nebulæ are more numerous in the vicinity of the large ones. As the "Selected Areas" are quite uniformly distributed over the sky, it would seem that the averages determined from them should form the more reliable basis for estimating the total number of nebulæ, within reach of the given instruments with the limits of exposure time used. Mr. Fath sums up the results of his investigation as follows:

1. "There is a great condensation of nebulæ toward the north galactic pole and a similar but much less marked one toward the south galactic pole.

2. "On the assumption that most of the nebulæ are approximately disk-shaped the planes of the disks appear to be oriented at random in space.

3. "The probable number of nebulæ in the sky which could be photographed with a 60-inch reflector with exposures of one hour with Lumière Sigma plates is 162,000.

4. "864 new nebulæ were discovered."

A World Without End.—Several writers on popular astronomy have described in an imaginative way the phenomena attending the destruction of all life at the end of the world, different writers calling into play the different possible causes which may bring about that destruction. Professor Gustave Jaumann, of the Brünn Polytechnic School, Germany, in an inaugural address on "Modern views of the End of the World" announces a very different doctrine. As quoted by a writer in the *Literary Digest* for June 14, 1913, he asserts that the modern view is that the universe is stable. Disturbing forces act only to call into being other opposing forces which will restore the balance of things. These views are the consequences of new theories of gravitation which take into account the fact that the gravitational impulse requires time to travel through space. Newton's law, on this view holds only for bodies at rest, whereas our system is in motion.

The following quotation from a translation of Professor Jaumann's address, as published in the *Revue Scientific* (Paris, May 10) is given in the *Literary Digest*·

"The anomalies of the field of gravitation are compensated, in cosmic space, according to a law analogous to that which governs the irregularities of distribution of temperatures in the mass of a conductor of heat. It is only for bodies at rest that Newton's law of effects at a distance follows exactly from the differential law of gravitation. The motions of the planets involve disturbances—a kind of accumulation, so to speak, of the field of gravitation in front of these bodies, giving rise to new gravitational forces which are added to the Newtonian forces.

"Although very small indeed, these forces may be calculated with great precision; the most important of them is in the direction of the planet's motion and thus aids that motion. It increases with the planet's velocity and varies in inverse ratio

to the distance from the sun. These new gravitational forces introduce into the movements of the planets disturbances that may be calculated without difficulty, and that determine the departures from Newton's law that have been noted above, such as abnormal rotations of the perihelion, abnormal accelerations, abnormal oscillations of the vertical, etc. Thus are explained all the peculiarities of gravitation, which Newton's law of action at a distance could not do. These new forces of gravitation, moreover, give to the planetary system a physical stability of practically unlimited extent. They preserve the present forms of planetary orbits, not only in spite of the considerable resistance due to friction with the cosmic ether, but despite huge accidental disturbances. If a perturbation of this nature, due, for instance, to the passage, near the solar system, of a fixed star at high speed, should completely change the form of the planets' orbits, the new gravitational forces would introduce into the elements of the orbits such variations that the orbits would return exactly to their present stable forms. Far from being fatal to us, the frictional resistance of the cosmic ether would appear only as a factor destined to give stability to the planetary orbits. The greater this resistance is, the more considerable are the new gravitational forces and the more obstinately will the orbits preserve their shapes, despite all disturbances. There can be no further question of the planet falling into the sun. Instead of being unstable, instead of tending toward a more or less distant destruction, the planetary system thus finds itself established for a period which, estimated by notions of time that we are able to conceive, may be regarded as eternal."

According to this view of gravitation the sun does not cool down, because the thermic energy which it must be all the time losing is restored by gravitational energy which it is continually absorbing from space in equal measure. The human race need not therefore necessarily perish. Its intellectual and physical evolution may continue indefinitely and will doubtless surpass anything that we are at present able to conceive.

Washington-Paris Longitude Campaign. Circular No. 7.

1. During the transfer of the members of the American and French longitude parties, with transit instruments, the schedule of longitude signals will of necessity have to be discontinued. The last signals of the first part of the observations will be sent on Wednesday evening, December 31, and it is hoped to resume the schedule about January 15.

2. In the meantime signals will be sent on the following schedule for the use of the special photographic registering apparatus, and these signals are of such a nature that they can not very well be used by any stations not equipped with the proper apparatus. They will probably begin January 2.

7:47	—7:49	Arlington calls.
7:50:00	—7:50:05	Arlington, 5 dashes.
7:50:30	—7:50:35	Arlington, 5 dashes.
7:55	—7:57	Arlington calls.
7:58	—7:58:05	Arlington, 5 dashes.
7:58:30	—7:58:35	Arlington, 5 dashes.

75th Meridian Mean Time.

J. L. JAYNE.
Captain, U. S. N.
Superintendent.

U. S. Naval Observatory,
Washington, D. C.
December 30, 1913.

Washington-Paris Longitude Campaign. Circular No. 8.

1. The Naval Observatory proposes to furnish the American Observatories who are utilizing the radio signals from Radio, Va., to determine their longitude, the data needed for the immediate reduction of their observations. The data thus furnished will be preliminary and will consist of the following;

(a) Riefler clock times of the first (or last) signal omitted from Arlington in each series, for the dates needed.

(b) The corrections to the Riefler clock as determined by the special longitude observations for the nights needed. For this preliminary determination only the observations of stars of the *American Ephemeris* will be used. Also the scale value of the level will be a preliminary one, and the azimuths will be preliminary.

2. For this purpose it is requested that all who desire such data, and who have not already done so, will at once notify the Observatory on what dates observations have been made.

3. Eventually, more accurate values of the clock corrections derived from all the data available for each night, reduced with definitive values of the level scale values, and definitive azimuths, will be made available.

4. Without in any way desiring to limit the privilege of each observatory to publish its work when and where it is desired, it is tentatively proposed that all the results of this campaign be eventually gathered together and published as part of the report of the present longitude campaign. The Observatory would be glad to know the opinion of the coöperating observatories as to the desirability of doing this. The idea would be to have each observatory prepare its own article, this Observatory editing only, to secure a certain amount of uniformity, and publishing each article under the name of its author.

J. L. JAYNE.
Captain, U. S. N.
Superintendent.

U. S. Naval Observatory,
Washington, D. C.
January 3, 1914.

Paris Washington Longitude Determination. Circular No. 9.

The regular schedule of signals from Arlington will be resumed on the 16th instant as follows:—

Arlington sends from	7-44-00 to 7-51-00	Eastern
" " "	7-53-00 to 8-00-00	Standard
" " "	8-13-00 to 8-20-00	Time

J. L, JAYNE.
Captain, U.S.N.,
Superintendent.

U. S. Naval Observatory,
Washington, D. C.,
January 14, 1914.

Comet Orbits.—The following persons are computing definitive orbits of certain comets and request that unpublished observations of the comets in question be communicated to them as soon as possible:

Professor C, Wirtz, Strassburg, Comet 1766 II.

Mrs. Terentjewa and Miss Martjanowa, St. Petersburg, Comet 1910 IV (Metcalf).

Mr. L. Lindsey, Syracuse, Comet 1911 II (Kiess).

Mr. J. Balonowsky, Poulkova, Comet 1913 *c*.

Publications Received.

Cooke, W, Ernest, Astrographic Catalogue 1900.0; Perth Section, Dec. —31° to —41°, Vol. III. Measures of rectangular coördinates and magnitndes of 20988 star images, R.A. 12^h to 18^h, on plates with centres in Dec. —32°.

Darken, Edward M., On the circulation of energy and matter.

Charlier, C. V. L., Das Strahlungesetz.

Charlier, C. V. L., Preliminary statistics of Nebulae and clusters.

Easton, C., A photographic chart of the Milky Way and the spiral theory of the galactic system.

Burns, Dr. Keiven, Das Bogenspectrum des Eisens.

Burns, Dr. Keiven, Mesures interférentielles de longueurs d'onde dans le spectra du fer.

Wolf, Dr. Max, Veröffentlichungen der Grossherzoglichen Sternwarte zu Heidelberg (Königstuhl), sechster Band, 1913.

Publications of the Carnegie Institution of Washington, Classified descriptive lists and index of authors.

Klotz, Otto, Stereographic projection tables. Pub. Dominion Observatory, Ottawa, Vol. I, No. 1.

Nelles, Douglas H., Precise Levels. Pub. Dominion Observatory, Ottawa, Vol. 1. No. 2.

Reid, F. B. Precise Levelling. Pub. Dominion Observarory, Ottawa, Vol. 1, No. 3.

Harper, W. E., Orbit of *d* Tauri. Pub. Dominion Observatory, Ottawa, Vol. 1, No. 4.

Klotz, Otto, Earthquake of April 28, 1913. Pub. Dominion Observatory, Ottawa, Vol. 1, No. 5.

Lacchini, G. B., Curva luminosa di Mira (*o* Ceti) 12 Luglio 1912-11 Marzo 1913.

Catalogo General de 5791 Estrellas 1900.0. Resultados del Observatorio Nacional Argentino, Tomo 20.

Annals of the Astronomical Observatory of Harvard College, Vol. LXXV, Part 1. Bond Zones of faint equatorial stars.

Bigelow, Frank H., On the coefficients and exponent of the radiation equation, $K_{10}=cT_{10}^{n}$, in the earth's atmosphere.

Barnard, E. E., The temporary stars. On the present appearance of some of these bodies.

Van Biesbroeck, G., Calcul approché des occultations.

Plaskett, J. S., Some recent interesting developments in astronomy.

Philippot, Dr. M., The legal time in various countries.

Abbot, C. G., and L. B. Aldrich. Smithsonian pyrheliometry revised.

Rigge, Rev. W. F., Saved by a shadow.

Hazard, Daniel L., Results of observations made at the United States Coast and Geodetic Survey magnetic observatory near Honolulu, Hawaii 1911 and 1912.

A plan for an institute for theoretical astronomical research.

Independent day-numbers for the year 1915 as used at the Royal Observatory, Cape of Good Hope.

Nossiter, C., Catalogue of 242 double stars, appearing on the astrographic plates, zone —32°. Perth Observatory Bulletin No. 1.

Annals of the Astronomical Observatory of Harvard College, Vol. LXXV, Part II. Contents of Volumes I to LXXV.

Annals of the Astronomical Observatory of Harvard College, Vol. LXXIV, A catalogue of 16300 stars observed with the 12-inch Meridian Photometer.